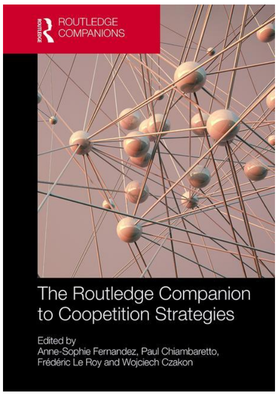

The Routledge Companion to Coopetition Strategies

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Coopetition and game theory

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Mahito Okura and David Carfì

Introduction

Many standard textbooks in microeconomic theory contain explanations of game theory, as it is a prominent section in microeconomics. However, there is one critical difference between game theory and traditional microeconomic theory. Traditional microeconomic theories, such as the perfect competition model, primarily focus on situations in which the decisions of one player (consumer and firm) never relate to the decisions of other players. However, this might not reflect in the real world. For example, the decision to lower prices in one supermarket might lead to decisions to lower prices in other supermarkets. In other words, one decision closely relates to other decisions. One attractive aspect of game theory is its ability to investigate such situations.

Although it is well-known that game-theoretical models are useful for analyzing various situations and markets, game theory is seldom used to investigate coopetitive situations. Coopetition studies have a long history. It has been more than twenty years since Brandenburger and Nalebuff (1996) published their pioneering study on coopetition; however, only a small number of studies have built game-theoretical models for investigating coopetition, such as Dearden and Lilien (2001), Okura (2007, 2008, 2009), Ngo and Okura (2008), Carfì and Schiliro (2012), Biondi and Giannoccolo (2012), Ohkita and Okura (2014), Arthanari et al. (2015), and Baglieri, Carfì, and Dagnino (2016).

There are three potential reasons why a game-theoretical model is seldom used in coopetition studies. First, most studies on coopetition are related to management rather than to economics. Moreover, game theory uses mathematical (and seemingly complex) models and equations based on (applied) microeconomics. Second, an important aim of many coopetition studies is to bring sophistication to the concept of coopetition and coopetition-related terms, such as value net. However, game theory seems unsuitable for this task. Third, case-study methods in coopetition studies are only moving towards quantitative methods as a common practice. These quantitative methods are based on observing situations and do not lend themselves readily to the game-theoretical model, which is mainly based on qualitative methods.

From this standpoint, the purpose of this study is to describe the advantages of game theory and how to use game-theoretical models in coopetition studies. To bridge the gap between coopetition studies and game-theoretical models, we describe the relationship between coopetition studies and game theory. Subsequently, we introduce the game-theoretical model of coopetition that appeared in the study by Okura (2009).

Game theory in coopetition studies

It is very important to understand that the infrequent use of game-theoretical models in coopetition studies does not imply that game theory is not useful for studies on the subject. For example, Brandenburger and Nalebuff (1996: 5–8) argued that game theory is useful for understanding coopetitive situations.[2] Lado et al. (1997: 113) argued that game theory can explain behavior in the context of inter-firm relationships. Clarke-Hill et al. (2003) and Gnyawali and Park (2009) explained a game theory approach in coopetition situation.[3] Okura (2007) explained the advantages of using game theory in coopetition studies. Pesamaa and Eriksson (2010) explained the usefulness of game theory for investigating actors' interdependent decisions. Rodrigues et al. (2011) applied game theory to investigating strategic coopetition. Ghobadi and D'Ambra (2011) summarized the characteristics, strengths, and limitations of using game theory in coopetition studies. Bengtsson and Kock (2014) pointed out that game theory is one of the research perspectives in coopetition studies. The game-theoretical models created by several studies enable research in several directions, such as insurance (Okura, 2007, 2009), green economy (Carfì & Schiliro, 2012), supply chain (Arthanari, Carfì, & Musolino, 2015), and R&D alliance (Baglieri et al., 2016).

Advantages of using game theory in coopetition studies[4]

There are three advantages to using game theory in coopetition studies.

The first advantage is that game theory is a very suitable methodology for analyzing inter-firm relationships because it can shed light on situations in which individual action significantly affects the payoffs of others (Shy, 1995: 11). Inter-firm relationships are a necessary condition to realize coopetition because coopetition is one of the situations that demonstrates a relationship among multiple firms. From this viewpoint, the market structures and conditions that are treated in both coopetition studies and game theory are very similar.

The second advantage is that game theory can easily depict coopetitive situations by isolating the cooperative and competitive aspects of coopetition using multiple stages. Coopetitive situation has a tendency to be complex because at least two aspects (competitive and cooperative aspects) appear simultaneously. Thus, both cooperative and competitive decisions, which have a close relationship, must be investigated. Game theory can also depict this situation and derive equilibrium stage by stage. In other words, multiple and complex relationships that consist of coopetition can be discomposed and analyzed.

The third advantage is that game theory is very rigorous and provides sophisticated solutions and equilibrium concepts. The discussions in game theory mainly consist of mathematical equations that are more objective expressions than verbal descriptions. Furthermore, the logical procedure of mathematical method is more formal than verbal description. For example, it is well-known that deriving first-order condition in an objective function is a typical way of discovering the optimal strategy. We insist, then, that results from game theory are very reliable; these results can be easily generalized, even if the focus of the analysis is specified. However, we also observe that game theory is not always the best methodology. Owing to the limitation in computation, the game theory model might contain some variables. However, the analysis in the game theory model might be insufficient to understand the actual situation, when neglected variables are critical for such explanation.

Representation of cooperation and competition in game theory

Suppose that a boy and a girl want to see a movie as a couple, and they have two choices, *Mission Impossible* (movie M) or *Pirates of the Caribbean* (movie P). Although the boy prefers to see movie M and the girl prefers to see movie P, both want to see a movie together. Thus, the boy's (girl's) preferences, in order, are as follows: see movie M (movie P) together, see movie P (movie M) together, see movie M (movie P) alone, and see movie P (movie M) alone. This game-theoretical situation is represented by the 2×2 matrix in Figure 12.1, referred to as Example 1 hereafter. In Figure 12.1, the pair of values in each cell (from left to right) represents the payoffs of the boy and girl, respectively. The matrix illustrates the players (the boy and girl), the strategies (movies M and P), and the payoffs (the values).

If the boy and girl simultaneously choose a movie, which one do they see? In other words, what is the outcome? This depends on the equilibrium, which is an important concept in game theory. In this game, the standard equilibrium concept used is the Nash equilibrium. As per this concept, "no player can profitably deviate, given the actions of the other players" (Osborne & Rubinstein, 1994: 15). Given this definition, the Nash equilibrium outcomes are "see movie M together" and "see movie P together." Although both outcomes cause the boy or girl to complain (for example, if "see movie M together" is the outcome, then the girl might complain), there is no alternative outcome that is better for both. In other words, this situation is somewhat competitive because either the boy or the girl can achieve the first best outcome. Then, a game such as that in Example 1 is sometimes termed the "battle of the sexes" (see, for example, Gibbons, 1992: 11).

Next, a slightly different situation can be considered. Suppose that the girl also prefers to see movie M instead of movie P. This implies that both the boy and girl want to see movie M. How does the Nash equilibrium change? To investigate this situation, we use the matrix in Figure 12.2, referred to as Example 2 hereafter.

Since the girl's preferences differ between Examples 1 and 2, her payoffs also differ. In this case, the Nash equilibrium outcomes are "see movie M together" and "see movie P together." Thus, although the girl's payoffs differ, the Nash equilibrium is the same in Examples 1 and 2. However, it is obvious that both the boy and girl prefer "see movie M together" to "see movie P together." Hence, if "see movie P together" were to be the outcome, both the boy and girl could do better by changing their strategies. However, "see movie P together" also constitutes the Nash equilibrium because both the boy and girl prefer to see a movie together.

One way of ensuring that the outcome is "see movie M together" or to rule out "see movie P together" is to introduce a coordinator to arrange the strategies. For example, suppose that a friend

		Girl	
		Movie M	Movie P
Boy	Movie M	5,3	2,0
	Movie P	0,2	3,5

Figure 12.1 The battle of the sexes

		Girl: Movie M	Girl: Movie P
Boy	Movie M	5,5	2,0
Boy	Movie P	0,2	3,3

Figure 12.2 The coordination game

		Firm B: High	Firm B: Low
Firm A	High	4,4	1,5
Firm A	Low	5,1	2,2

Figure 12.3 The Prisoner's Dilemma

of the boy and girl plays the role of the coordinator. In this situation, by indicating what strategies are desirable, the coordinator can ensure that the best outcome ("see movie M together") prevails. It denotes that the coordinator can ensure that cooperation between the boy and girl improves both their payoffs. In other words, this situation is somewhat cooperative because both boy and girl can achieve the first best outcome with the help of the coordinator. Subsequently, because it highlights the importance of coordination between players, a game such as that in Example 2 is sometimes termed a "coordination game" (for example, Osborne & Rubinstein, 1994: 16).

In Example 2, although an undesirable outcome constitutes the Nash equilibrium, a desirable outcome might emerge even in the absence of a coordinator. However, it is possible for an undesirable outcome to constitute a unique Nash equilibrium. In other words, a desirable outcome never emerges in the absence of a coordinator. To analyze such a situation, we introduce a different example, referred to hereafter as Example 3. Suppose that two firms, A and B, sell identical products to consumers. Firms choose between "high price" and "low price." Firm A's (B's) first preference is that firm A (B) chooses "low price" and firm B (A) chooses "high price." This would give firm A (B) a competitive advantage and higher profits. Firm A's second preference is that both firms choose "high price." Its third preference is that both firms choose "low price." The worst preference of firm A (B) is that firm A (B) chooses "high price" and firm B (A) chooses "low price," in which case many consumers would buy the product from firm B (A). The Example 3 is illustrated by the matrix in Figure 12.3, wherein the pair of values in each cell (left to right) represent firm A's and firm B's payoffs, respectively.

In Example 3, a unique Nash equilibrium is achieved when "both firms choose low price." It is obvious that a better outcome is realized when "both firms choose high price" than when "both firms choose low price." However, unlike in Example 2, the Nash equilibrium is not achieved when "both firms choose high price." Hence, in Example 3, a desirable outcome cannot emerge from voluntary actions. In this case, a third party acting as a coordinator might produce a desirable outcome.

It is noticed that the coordination required in Example 3 differs from that required in Example 2. In Example 2, the desirable outcome ("see movie M together") constitutes the Nash equilibrium. Thus, the coordinator simply informs the boy and girl of the best strategy. Contrarily, in Example 3, the desirable outcome ("both firms choose high price") is not a Nash equilibrium. Thus, even if the coordinator informs both firms of the desirable strategy, either of the firms will want to deviate from it because the desirable strategy will not be the best strategy for each individual firm. Either rules and incentive mechanisms or both will be needed to prevent such deviation. In summary, cooperation is more difficult in Example 3 than in Example 2. Labeling "both firms choose high price" and "both firms choose low price" as "cooperation" and "competition," respectively, clarifies why cooperation is more difficult to achieve in Example 3. The game in Example 3 is the well-known "Prisoner's Dilemma," in which a desirable outcome does not necessarily emerge even if the players pursue their preferred strategies.

Finally, for a later discussion on coopetition, we summarize these three results in terms of cooperation. In Example 1, there is no room to coordinate each choice because an outcome in which both the boy and girl are better off does not exist. In Example 2, a coordinator might change to an outcome in which both the boy and girl are better off. However, it may be possible to obtain the best outcome without the coordinator because it will also be a Nash equilibrium. Thus, there might be no room to coordinate each choice. In Example 3, the best outcome is never realized without a coordinator. Thus, a coordinator is surely needed for realizing the best outcome. From this perspective, we find that introducing a coordinator is critical for realizing cooperation in the case of the Prisoner's Dilemma.

The representation of coopetition in game theory

In many coopetitive situations, players such as individuals and firms choose their strategies sequentially, which gives rise to multiple types of strategies. For example, suppose that firms choose product quality and price. Firms normally choose quality before choosing price. Moreover, the quality level chosen in the first stage is arguably related to the subsequent pricing decision. Game theory can also be used during the analysis of sequential choice structures.[5] In addition to the players, strategies, and payoffs, a set of moves must be included. In the above example, quality choice is the first move and pricing is the second.

To illustrate the sequential moves, we incorporate sequential moves into Example 1. We introduce a "ladies-first rule," which allows the girl to choose first, instead of allowing the boy and girl to choose their strategies simultaneously. To determine the outcome in this situation, we must apply an appropriate equilibrium concept. In the terminology of game theory, it is referred to as the subgame-perfect equilibrium. Simply put, the subgame-perfect equilibrium is the Nash equilibrium in which the strategies of players represent a Nash equilibrium in each "subgame" of the original game. The subgame-perfect equilibrium can be derived by computing the Nash equilibrium at each sequential move. In game theory, it is standard practice to determine the subgame-perfect equilibrium by using "backward induction." According to the explanation in Fudenberg and Tirole (1991: 68–69), backward induction "is to start by solving for the optimal choice of the last mover for each possible situation he might face, and then work backward to compute the optimal choice for the player before." In the price–quality example, this involves analyzing the pricing decision first, although price is chosen second.

The application of backward induction to Example 1 with the ladies-first rule reveals that the unique subgame-perfect equilibrium is achieved when they choose to "see movie P together." The introduction of sequential moves into Example 1 eliminates one Nash equilibrium of the game ("see movie M together") because the girl is the first mover and she can decide which movie the couple sees together.

The sequential game represents a useful way of analyzing coopetitive situations because players choose multiple kinds of strategies and some (or all) of these strategies have decision orderings and relationships. To explain how coopetitive situations can be analyzed, we use Example 4, which is based on the research by Okura (2009).

Suppose that two insurance firms, A and B, play a two-stage game. In the first stage, both insurance firms decide whether to disclose the information about their policyholders for preventing insurance fraud. Such disclosure reduces insurance fraud in the insurance market and increases the benefits of both firms. Thus, the decision in the first stage may be cooperative as well as competitive. In the second stage, both insurance firms choose the quantities of insurance products. An increase in the quantities of insurance products in a rival insurance firm leads to a decrease in a firm's own quantities of insurance products. Thus, the decision in the second stage is surely competitive.

By backward induction, we first investigate the second stage. The amount of insurance in each insurance firm depends on the decisions made during the first stage. Thus, we must consider the second stage in all possible situations. In this game, there are four possible situations, that is, "both firms disclose information," "firm A discloses information and firm B does not disclose information," "firm A does not disclose information and firm B discloses information," and "both firms do not disclose information." It is obvious that the situations in "both firms disclose information" and "both firms do not disclose information" depict the lowest and highest amounts of insurance, respectively. In accordance with the amount of insurance, each insurance firm chooses a different quantity of insurance under the competitive insurance market. Subsequently, we derive the equilibrium quantity of insurance in the four possible situations by simple microeconomic theory.

After finishing the analysis in the second stage, we proceed to investigate the first stage. In the first stage, each insurance firm chooses whether to disclose its information. Subsequently, we depict that situation in a 2×2 matrix in Figure 12.4.[6]

It is evident that a unique subgame-perfect equilibrium is achieved when "both firms choose no disclosure," while it is undoubtedly better for "both firms to choose disclosure." Such disclosure would reduce insurance fraud and benefit both firms. However, benefits from a disclosure affect not only the firm that chooses disclosure but also the firm that chooses not to disclose. Thus, this gives each firm an incentive to free-ride by not disclosing. Such an undesirable outcome can be resolved by coordinating firms' decisions during the first stage. In addition, we observe that this result is maintained even when the number of insurance firms is more than two, because we can interpret "firm A" as "representative firm" and "firm B" as "other firms" in the model in Okura (2009).

		Firm B	
		Disclose	Not disclose
Firm A	Disclose	6,6	1,8
	Not disclose	8,1	2,2

Figure 12.4 The disclosure game

This result can explain the need for an information-exchange system such as the Life Insurance Network Center (LINC) in the life insurance market in Japan. The LINC compels all life insurance firms to disclose information. Thus, it can avoid realizing any undesirable outcomes. Finally, we know that cooperation and competition are realized in the first and second stages, respectively, and then a coopetitive situation is generated.

Example 4 shows that a game can combine cooperative and competitive elements and it can be analyzed stage by stage. Even if cooperative and competitive aspects are related, game theory facilitates formal derivation of results by using techniques such as backward induction.

Concluding remarks

In this study, we discussed the advantages of game theory and how game-theoretical models can be utilized in coopetition studies. Subsequently, we bridged the gap between coopetition studies and game-theoretical models. Our contribution is twofold. First, we explained the advantages of using game theory in coopetition studies. The advantages of game theory are: 1) it is a suitable methodology for analyzing inter-firm relationships; 2) it can discompose a coopetitive situation stage by stage; and 3) it can give very rigorous, reliable, and general results. Second, we showed the manner in which the game-theoretical model can be used in coopetition studies. We introduced the model used in Okura (2009), which depicted information-disclosing strategies to prevent insurance fraud. From the model's results, we understand that insurance firms cannot realize the best solution in a competitive insurance market; however, they can achieve this through a coordinator. In actuality, the Life Insurance Network Center becomes a coordinator, leading to cooperative information disclosure in the coopetitive insurance market. We imply that game theory can explain perspectives of actual coopetitive situations. For example, in this study, we introduced the model used in Okura (2009) for showing insurance firms' coopetitive information-disclosing strategies, in which all players are better off.

Many researchers in game theory are interested in analyzing coopetitive situations. Furthermore, the introduction of game-theoretical models in coopetition studies should foster collaboration among researchers in management and economics. The collaboration can formalize the choices of players and show policy implications. In addition, game theory can explain various situations by changing the settings and/or assumptions. Then, using game theory models, it is possible to compare many situations. In other words, we can compare situations in two countries or firms and understand how to achieve coopetition, what types of coopetition appear, whether coopetition is socially desirable, and so on. Ultimately, we believe that the study of coopetition within game theory has a wide variety of promising research agendas.

Notes

1 This article is a revised version of our article published in the *Journal of Applied Economic Sciences* 9(3) (Fall 2014): 457–468. This work was supported by JSPS KAKENHI Grant Number JP15K03727 (Mahito Okura).
2 Stein (2010: 257) mentioned that Brandenburger & Nalebuff (1996) "explain 'co-opetition' as an approach that intends to explain competition and cooperation in business networks in the spirit of game theory."
3 However, Clarke-Hill et al. (2003) used both co-operation and competition instead of coopetition.
4 This section is greatly indebted to the research by Okura (2007).
5 To simplify the explanation of sequential games, we omit strict definitions and proofs. For details of such definitions and proofs, see, for example, Gibbons (1992: Chapter 2).
6 Okura (2009) mathematically computed whether to disclose information. However, for simplicity, we represent the numerical example in Figure 12.4.

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