

# Application of Nash Equilibrium: Taking the Game Between Enterprises as an Example

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**Abstract.** The game theory of microeconomics is one of the important analysis and decision-making tools for managing enterprises. Von Neumann discusses the zero-sum game of two people, while Nash discusses a broader range of games. This paper aims to explore the important concept of Nash Equilibrium in game theory. With the wide application of Nash Equilibrium in different fields such as economics, politics, psychology and machine learning, it is becoming increasingly important to understand and apply Nash Equilibrium. The author first introduces the concept and mathematical definition of Nash Equilibrium, and then takes the "Prisoner's Dilemma" game as an example to elaborate its application methods and significance in detail. Subsequently, the author discusses the limitations of Nash Equilibrium, including the inability to guarantee the maximum profit, and proposes corresponding solutions. Finally, the author explores the applications of Nash Equilibrium in different fields, as well as the prospects in machine learning and artificial intelligence fields.

**Keywords:** Game theory; Nash equilibrium; enterprises game.

## 1. Introduction

As an important concept in game theory, Nash Equilibrium has been widely applied in various fields. In economics, Nash Equilibrium is used to analyze market competition, pricing strategies and industry organizations. In political science, Nash Equilibrium is applied to analyze international relations, game theory diplomacy, etc. In psychology, Nash Equilibrium is used to analyze cooperation and competition, decision-making, etc. With the development of machine learning and artificial intelligence technology, Nash Equilibrium has also been applied to the design of adaptive intelligent agents, adversarial networks in machine learning, etc.

The development of game theory can be traced back to a classic problem posed by mathematician Pierre de Fermat in the late 19th century, namely, "who is the winner?", in which he proposed the basic concepts and theoretical framework of game theory. However, it was not until the 1940s that game theory gradually became an independent research field, largely owing to the efforts of economists, such as Von Neumann, whose works, "Theory of Games and Economic Behaviour", first presented the basic concepts and theoretical system of game theory and offered many classic cases [1].

Game theory studies the decision-making process in the game, which is not only a mathematical theory, but also a way of thinking for solving decision problems. Game theory provides a new perspective and method for solving various decision problems by establishing models and analyzing strategies. The research results of game theory have been applied not only in the field of economics, but also in many other fields such as political science, biology, computer science, psychology, sociology, etc. In game theory, Nash equilibrium is a basic concept. Nash equilibrium refers to the state in which all players choose the best strategy for themselves in a certain game, which is a classic game strategy. The Prisoner's Dilemma is one of the most famous cases in game theory, which is also widely used in research in various fields. In this paper, taking the Prisoner's Dilemma as an example, the concept and application method of Nash equilibrium will be introduced in detail. In addition, the author will also discuss the limitations of Nash equilibrium and solutions, as well as the applications and prospects of Nash equilibrium in different fields [2-4].

Through this study, readers can gain a deeper understanding of the core concepts of game theory and the applications and limitations of Nash equilibrium. The author believes that this would help readers better grasp the theory and practice of game theory, as well as provide new insights and

directions for future research. The author hopes this paper can guide readers to better understand game theory and Nash equilibrium, and encourage more scholars and researchers to participate in the research of game theory.

The research methodology of this paper mainly focuses on literature review and theoretical analysis. The author first introduced the basic concept and application of Prisoner's Dilemma game, and then elaborated the concept and application method of Nash equilibrium. Subsequently, the author analyzed the limitations of Nash equilibrium, especially in the application of repeated games. Finally, some methods and schemes to overcome the limitations of Nash equilibrium were proposed and the applications and prospects of Nash equilibrium in different fields were discussed. The research results of this paper show that Nash equilibrium as a game strategy can be applied to decision-making problems in various fields and has already been widely used in practice [5,6].

However, Nash equilibrium also has some limitations, especially in the application of repeated games. To overcome these limitations, scholars can take some methods and schemes, such as introducing uncertainty and establishing trust mechanisms. In conclusion, this study aims to explore the core concepts and strategies in game theory, especially the applications and limitations of Nash equilibrium. The author hopes that this paper can provide new perspectives and methods for the research and application of game theory, and also provide readers with a comprehensive reference of game theory.

## 2. Case Analysis

This case involves two companies, Company A and Company B. Both companies produce the same type of product, thus creating a direct competitive relationship between them. Each company has a market share of 50%, and both companies desire to acquire a greater market share by adjusting their pricing strategies. Specifically, each company can choose either a high pricing strategy or a low pricing strategy, with their profits related to the pricing strategies they choose. If both companies adopt the same pricing strategy, their market share will remain unchanged. If one company adopts a high pricing strategy while the other adopts a low pricing strategy, the company with the low pricing strategy will acquire a greater market share. If both companies adopt a low pricing strategy, their market share will remain unchanged, but their profits will be reduced.

Nash equilibrium has many examples in reality. For example, in the price war in the business world, both sides are hurt, but "if the other side uses the means, I also have to use it, and whoever changes first will be unlucky". This is a Nash equilibrium. Group conflicts, political disturbances and international disputes may all lead to such deadlock. If we don't discuss jumping out of the game, we will always "catch each other's hair" and lock together. A classic example of game theory that is often cited is the prisoner's dilemma. The two suspects entered the police station and were interrogated separately. The prosecution issued the following conditions: both of them confessed and were sentenced to 8 years each; They pleaded not guilty and were sentenced to six months each; If one denies and the other confesses, the confessor will not be sentenced to 10 years. If the two people are loyal and willing to wear the prison for their brothers, then they will be sentenced to six months each, "Resist strictly and go home for the New Year". How nice! But the prisoner here is too smart. He only wants to maximize his own interests, and believes that his companions are also such people. Therefore, the prisoner reluctantly knew that both of them would choose to confess and would be sentenced to 8 years each. Nash also put forward a "smart pig game", which is widely quoted: one big and one small two pigs. There is an automatic feeding machine in the pigsty, and one corner of the pigsty is a pedal. If you step on it, the pigsty will drop the feed diagonally. But there is a time difference between stepping on the pedal and eating. The smart pig will think, "When I step on it, the other pig will eat it before feeding. I'm not worth it [7-9].

### 3. Issues Analysis

In the aforementioned case, there are four different pricing strategies adopted by the two companies, namely, high price by Company A, high price by Company B; high price by Company A, low price by Company B; low price by Company A, high price by Company B; and low price by Company A, low price by Company B. The author represents the different pricing strategies and the corresponding profit using a game matrix as table 1:

**Table 1.** Game matrix

		B	
		High Price	Low Price
A	High Price	50,50	20,80
	Low Price	80,20	60,60

An examination of the game matrix reveals that when both companies adopt the high-price strategy, their returns are both 50. If Company A adopts the high-price strategy while Company B adopts the low-price strategy, Company A's returns are 20 while Company B's returns are 80. If Company A adopts the low-price strategy while Company B adopts the high-price strategy, Company A's returns are 80 while Company B's returns are 20. When both companies adopt the low-price strategy, their returns are both 60.

In this scenario, each company has two different strategies to choose from, thus leading to four possible cases. When both companies adopt the high-price strategy, this is a Nash equilibrium state, as under this situation neither company can increase their returns by changing their strategies. Likewise, when Company A adopts the high-price strategy while Company B adopts the low-price strategy, this is also a Nash equilibrium state, as neither company can increase their returns by changing their strategies. Similarly, when Company A adopts the low-price strategy while Company B adopts the high-price strategy, this is a Nash equilibrium state as well. However, when both companies adopt the low-price strategy, this is not a Nash equilibrium state, as Company A can increase its returns by changing its strategy, leading to an unstable strategy set [10].

### 4. Suggestions

In this case, if both companies adopt a high price strategy, their returns would be 50. Although this is a Nash equilibrium state, the profits of both companies are not maximized. Therefore, Company A can adopt a low-price strategy, which will increase its market share and thus increase its profits. At the same time, Company B can also adopt a low-price strategy, which will reduce its market share, but since the total market size remains unchanged, Company B's profits may be slightly reduced but still obtain decent profits. In this scenario, both companies can achieve relatively maximum profits, and this is also a Nash equilibrium state.

Of course, this suggestion is only for this specific case and may not be applicable to other similar situations. In practical application, participants need to select the optimal strategy according to different situations, and at the same time, we need to consider other factors, such as market demand, product quality, cost, etc.

Additionally, we recommend that the companies engage in open and transparent communication to improve their information sharing. This can include sharing information about their cost structures and production capacities, which can help to reduce uncertainty and improve decision-making.

### 5. Conclusion

In this paper, the author introduced the concept of Nash equilibrium and analyzed its significance and limitations in practical application through an illustrative example. Meanwhile, this paper also explored the applications of Nash Equilibrium in different fields, and looked forward to the prospects

in the fields of machine learning and artificial intelligence. This study found that Nash equilibrium can help us to predict the ultimate outcome in games involving multiple participants, as well as to find the optimal strategies, but it may not necessarily maximize profit. Therefore, in practical application, we need to select the optimal strategies according to specific circumstances, while taking other factors into consideration.

Nash equilibrium is an important concept in game theory that can be applied to various fields such as economics, political science, psychology, etc. In economics, it has been widely applied to analyze market competition, pricing strategies, industrial organization, etc. In political science, it has been applied to analyze international relations, game theoretical diplomacy, etc. In psychology, it has been applied to analyze cooperation and competition, decision-making, etc. Although Nash equilibrium suffers from certain limitations in practical application, it remains an important concept in game theory that can help us to better understand human behavior and social phenomena. With the continuous development of machine learning and artificial intelligence technologies, Nash equilibrium has also been applied to design adaptive intelligent agents, and adversarial generative networks in machine learning, which has a broad application prospect. The author needs to choose the optimal strategy according to the specific situation, and consider other factors. The concept and methods of Nash Equilibrium are of great importance for us to better understand human behavior and social phenomena.

At the same time, this paper also has some deficiencies in the research methods. In the process of research, this paper focuses on the carding of theory and the description of classical content, but lacks the calculation of equivalence. At the same time, in the aspect of problem analysis, due to the limited access to data resources, there is a lack of quantitative analysis of data in the analysis process, which can be expanded in the future.

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