

## THE APPLICATION OF ECONOMIC GAME THEORY -- TAKING THE ACTUAL PHENOMENON AS AN EXAMPLE

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### ABSTRACT

The game theory as a branch of mathematics provides us with a general method for studying human rational behavior. Using these methods, we can more clearly and completely analyze the phenomena observed by the interacting decision-making subjects. This article first briefly discusses the development of game theory. On the basis of this, explaining the contradiction between individual rationality and collective rationality with the prisoners' predicament game theory and expand the phenomenon. The idea of free-riding between unequal participants' game is explained through the thinking of pig-pig game. Through imperfect information market entry game thinking analysis of incomplete information on the impact of transaction efficiency. Analysis of infinite repetitive games with the cool strategic thinking of repeated games can make prisoners out of the woods. Use game theory to explain phenomena in real life. From everyday life games, playing chess to cooperation innovation between companies. While the discipline itself is developing and improving, it also requires game theory to move toward more explanatory power.

**Keywords:** Economic game theory ; dialectical thinking ; Nash equilibrium; Prisoner's dilemma ; incomplete information.

### INTRODUCTION

Game theory, as an important branch of mathematics, is an important subject under the applied disciplines of operations research, and it is also a wise topic. It is of great significance in guiding people's production and life practices and is currently one of the most cutting-edge applications in applied mathematics. The traditional economics neglects the interpersonal behavior or decision-making interaction, and then develops the game theory is to study the influence of the bureaucratic tactics and balance of science. Small to do mahjong, play chess. Big to compete between enterprises, game between bidders and bidders, etc. In short, the choice of strategy for studying one subject is influenced by other subjects and, in turn, affects the choice of other agents.

Game theory is the science that abstracts the situation of confrontation between the two parties in real life, and uses mathematical thinking to study it. The game theory problem includes the following elements: First, the two sides of the game are in a confrontational relationship, and there will be conflicts of interests and mutual influence; secondly, both sides of the game have multiple possible action plans; finally, both sides of the game are rational people. In the case of full consideration of all possible alternatives of the other party, choose the one that is most beneficial to you. That is to say, in game theory, it is necessary not only to consider all possible alternative strategies of one's own side, but also to examine the possible benefits of the counterparty based on the information, actions and strategies of the counterparty, in order to maximize their own benefits in conflicts as far as possible.

The idea of game theory can be reflected from the Tian Ji horse race in ancient China, and the foreign one starts from the French oligopoly competition model of Cournot. Marked the game theory is produced by the United States Princeton mathematician von Neumann and Morgenstern, co-author of "Game Theory and Economic Behavior", Nash equilibrium laid the theoretical foundation, Then, Hassani's "Bayesian game of incomplete information game" and Zerten introduced "sub-game refined Nash equilibrium" and "shaking hand balance" on the basis of the original improvements.

Based on the introduction, this article explains the contradiction between individual rationality and collective rationality from the prisoners' predicament game thinking and expands its phenomenon, explaining the free-riding between unequal participants from the perspective of the game of pigs, From imperfect information market to game theory, this paper analyzes the influence of imperfect information on transaction efficiency and analyzes the infinite repetition game from the cruel strategic thinking of repeated games to make prisoners get out of the predicament. Trying to explain most phenomena in life with game thinking.

### **Nash Equilibrium**

Undoubtedly, the concept of equilibrium is of great significance to many scientific fields. The so-called equilibrium indicates that things are in a balanced or stable state. Stability is the core concept of understanding many natural processes, and it is also the state we are craving for now, permeating all aspects of life. There is a well-known theory "Nash equilibrium" in equilibrium thinking, also known as non-cooperative game equilibrium. Nash equilibrium refers to a combination of strategies. This combination of strategies consists of the optimal strategies of all people in the bureau. In other words, given the strategies of others, no single player has the enthusiasm to choose other strategies, so that no one has the enthusiasm to break this equilibrium. The balanced solution is the result of no regrets. The popular saying is that: When the interests compete, everyone will do this principle. If others do not change their strategies, it is impossible to increase their own interests when their individual unilaterally changes their tactics. This leads to a state of equilibrium, often called the "Nash equilibrium." The Nash equilibrium state is a state where any individual deviation will not improve.

Nash equilibrium is an important term for game theory. It refers to the assumption that there are  $n$  players participating in the game. Given the strategies of other people, each player chooses his or her best strategy to maximize his own interests. That is, given the strategy of others, no one has enough reason to break this equilibrium.

Game theory describes a situation in which opposing parties face multiple strategies in the case of conflict. Then we can't help but ask, what kind of choice will the two parties eventually make in this case? Nash equilibrium answers this question.

Non-cooperative game Nash equilibrium assumes that both sides are contradictory and conflicting, and the parties to the conflict of interest are not cooperative and win-win. Under this relationship, both parties will decide on a plan to maximize their own interests based on the possible choices of the other party. This maximization of interests is the party that makes the decision, not the two sides. When both parties think that there will be no better choice than the present, that is, improvement of the current situation can not enhance their own interests, both parties have no incentive to change the current decisions, then the current

situation is the Nash equilibrium solution. That is to say, under the premise that people have already made certain strategic choices in other bureaus, each director will choose the best strategy for himself according to the strategy of others. The best strategy combination for all players is Nash. balanced.

### Prisoners' Dilemma - Contradiction between Individual Rationality and Collective Rationality

One example we all know very well about prisoners' dilemmas is that the police seize two criminal thieves but lack evidence to convict them if at least one of them pleads guilty. In order to get the confession, the two will be interrogated separately. The result is that if one person confession but the other does not move, then the donor is immediately released, not to imprisonment for 10 years in jail. If both of them confess their confessions, they will each be sentenced to eight years' imprisonment. If both of them do not confess their confessions, they will each be detained for one year without obtaining any evidence. Assuming a rational actor, a, whether B is to choose to recruit or not move, choose "trick" than choose "not move" to be better. Therefore, "not move" is relative to the "trick" strict inferior strategy, so A will choose "trick." Similarly, according to symmetry, B will choose "trick", so Nash equilibrium solution is that both A and B confessions for 8 years. From this example, we can find the equilibrium solution of the problem by using the method of "removing strict inferior strategy." Although both A and B choose "no trick" as the collective best, both A and B have the incentive to depart from this result, and there is a conflict between individual rationality and collective rationality. Assuming that neither of them is a confederate, one can make more profit as long as one of them transforms. For this reason, even if both A and B have no agreement on confession to be provided earlier, such agreement can only be "a promise without threat", and therefore the Nash equilibrium solution has inherent stability.

In this example, no one will actively change his strategy in order to make himself more profitable. The "prisoner's dilemma choice" has a wide and profound significance. The final outcome of the conflict between individual rationality and collective rationality, and the pursuit of self-interested behavior, is a "Nash equilibrium", and it is also an unfavorable outcome for all. Both of them are the first to think of themselves in their confession and denial tactics, so that they are bound to serve long sentences. Only when they first think about each other, or collaborate with each other, can they get the result of imprisonment for the shortest possible time.

Prisoners Dilemma Game Payment Matrix:

		Prisoners two	
		Frank	Deny
Prisoners one	Frank	-8, -8	0, -10
	Deny	-10, 0	-1, -1

From the simple example of prisoner's dilemma, we can conclude that confession is the best choice between the two; (deny, deny) can not achieve the better Pareto improvement, and thus the prisoner can not get out of the dilemma; the Nash equilibrium strategy has a relative Stability; also highlights the contradiction between individual rationality and collective rationality; finally concluded that the institutional arrangements to be implemented, Nash

equilibrium must be formed. Further expanding the problem of road building in front of the poor, public tragedy and oligarchic competition all belong to the solution of such problems.

**Wisdom Pig Game - Free-rider Phenomenon**

The chances and status of both participants in the Prisoners' Dilemma are equal, but if the participant's status is not equal, such as the game of eating big pigs and piglets, assuming that there is a big pig and a piglet in the pigsty, one end with a button, click, 10 units into the slot, but to pay 2 unit cost. If the first big pigs to eat 9 units of pigs to eat 1 unit; if the pig first to eat 6 units of pigs to eat 4 units; if at the same time to eat pigs to eat pigs to eat 3 units; if not to press, neither can eat.

In fact, the small pig chose to wait and let the big pig press the control button. The reason for choosing "hitch-hiking" is very simple. Under the premise that the big pigs choose to act, if the piglets are also in action, the pigs will receive a net income of 1 unit; if the piglets wait, they will receive a net income of 4 units and wait for better than the action. Under the premise that the big pigs choose to wait, if the piglets act, the income of the pigs will not be offset, and the net income will be -1 units. If the piglet also chooses to wait, the piglet's return is zero and the cost is zero. In short, waiting is better than action.

In small business operations, learning how to "free ride" is the most basic quality of a savvy professional manager. At some point, if you can wait and wait, let other big companies develop the market first, it is a wise choice. At this time there are some talents. Smart managers are good at using all kinds of favorable conditions to serve themselves."Hitchhiking" is actually another option for professional managers to face every expense. Attention and research on it can save the company a lot of unnecessary expenses, so that the management and development of the enterprise can go on a new steps. This phenomenon is very common in economic life, but it is rarely known to small business managers.

Wise pigs game payment matrix:

		Small pig	
		Press	Wait
Big pig	Press	5, 1	4, 4
	Wait	9, -1	0, 0

The matrix is balanced (press, wait), the result is (4,4) the result is more than the labor do not have too much. Among the participants, the inequalities of the two men, such as the rich and the poor, in front of the poor, can occupy the light of the rich. In the market, between the large stock market and the retail investors, the individual investors can follow the footsteps of large investors to save money cost; in the supervision of the big shareholders and minority shareholders on the managers, the minority shareholders can benefit from the supervision of major shareholders; the development of new products for big and small enterprises, small enterprises can use backward advantages to imitate the technological innovation of large enterprises , catch the big car business.

### Incomplete information into or out of the case

In the above game hypothesis, we assume that all participants know that all participants know the payment function of all participants, but show that many games in life do not satisfy the requirement of complete information. Let's look at an example of a market entry blocking game: a potential entrant decides whether to enter a new industry without knowing the cost function of the incumbent firm nor the incumbent's decision to acquiesce or fight.

Assuming two potential costs for the incumbent: High cost and low cost, the corresponding payment matrix for the different strategic combinations is as follows:

		Current person in office			
		High cost situation		Low cost situation	
		acquiescence	struggle	acquiescence	struggle
Entrants	Enter	40, 50	-10, 0	30, 80	-10, 100
	Do not enter	0,, 300	0, 300	0, 400	0, 400

In the above example the incumbent's best choice is acquiescence if the incumbent is a high-cost given entrant, and the incumbent's best choice is the fight if the incumbent is a low-cost given entrant. But now the entrant does not know whether the incumbent is low cost or high cost so that the optimal choice of entrant depends on how much it considers the incumbent to be either high cost or low cost.

Assuming that the probability that the incumbent will regard the incumbent as a high cost as  $p$  and the probability of a low cost as  $(1-p)$ , the expectation of the entrant to choose to enter is  $40p + (1-p) \times (-10) = 50p-10$ , The expectation of choosing not to enter is 0. That is when  $p > 1/5$  the entrant enters, and  $p < 1/5$  entrants do not enter.

In the subsequent development of the incomplete information model and the supply of public goods belong to Bayesian equilibrium. Among them, the Bayesian equilibrium of auction bidding is from the first sealed auction or the dark auction, but the Bayesian equilibrium of this game is that each bidder is bidding at half of its actual price. Moreover, the difference between the bidder's bid and the actual value decreases as the number of bidders increases. However, there is no Bayesian equilibrium in the bid-ask auction that enables Pastore to be valid and that only Pastor-valid deals will occur. The emergence of secondary seal price auction law can not only avoid the mark, but also induce buyers to make a true valuation. With the study of bidding auction mechanism and the setting of auction mechanism, the game thinking goes deeper and deeper into life.

### Out of the dilemma of the repeated game

Repeat game refers to the game process in which the basic game repeats. Although in the form of repeating the game is the basic game repeat process, but the game player's behavior and game results have different results. Because the game players repeat their awareness of the game, they will change their judgment of interests, so that they can choose different behaviors to deal with in different stages of repeated games. This makes it impossible for us to consider repeating games as a simple addition to the basic game. We should study the whole process of repeated games as a whole. And repeated games have certain universality in real life. Our research on it has important implications for long-term repeated cooperation or competitive relationships.

All kinds of games mentioned above are the analysis of a game process. However, in the real economy, there are a lot of repeated game phenomena, for example, the two men play a few chess games and a few laps mahjong all belong to the repeated game. During the repeated stages of the game, the structure of the game remains unchanged. In the new stage of game, each participant knows the actions of each participant in each game in the past. The participant's total payment is the sum of the discounted value paid by all stages of the game. The main factors affecting the outcome of the repeated game equilibrium are the number of repeated games and the completeness of the information. When the game is conducted once, each participant only cares about the one-time payment, and when repeated several times, the participant may adopt a balanced strategy of cooperation at the expense of the immediate interests in the long-term interest. Completeness is that when a person's payment function is not known to other participants, the participant may be motivated to establish a good reputation in the long-term interest. This can explain those who are not good in nature, but for a long time did a good job.

The incarceration is not a credible threat as market entry evolves into a limited number of repeated games, which in turn plunges into the (paradoxically) chain paradox. Prisoners' dilemma game is similar to this. As long as the number of game repetitions is limited, the two sides always confess the strategy is the only subgame perfect Nash equilibrium. Therefore, a limited number of repeated games of complete information can not solve the problem of non-cooperation.

Let us look again at the infinitely repeated game, let the prisoner's dilemma repeat infinity and adopt the cold strategy, after countless times, the cold strategy is a subgame perfect Nash equilibrium of the infinite prisoner game. (Repudiation, repudiation) is the result of the equilibrium at each stage and the prisoner is out of the woods.

The rationale for game theory is that any short-term opportunistic behavior is negligible if the game is repeated indefinitely and each participant is patient enough. Participants are motivated to establish themselves as a willingness to cooperate and have the opportunistic punishment of each other's opportunistic behavior. Furthermore, the cooperation of a group depends not only on the rules, but also on the number of personnel in the group. The greater the number, the less co-operation is easy. This also explains the fact that the more partners that do bad things, the more likely they are to be exposed. Visible game theory can explain many phenomena in reality.

## CONCLUSION

"Economic game theory" is a discipline that combines game theory principles with economic issues and analyzes the game choices of various players in economic activities. Traditional economics tends to ignore the reactions of various aspects of economic activities in their actions or decisions. Game theory makes up for this inadequacy of traditional economics. In the analysis method, the analysis method based on individual isolated decision-making of traditional economic analysis was changed, and the interaction and influence of the behaviors of multiple interest subjects in economic activities were focused on, so that the economic analysis could better reflect the nature of the economic system. Second, it highlights the rational human factor in economic analysis. Game theory starts from the angle of behavior analysis, and insists and highlights the role of individual rationality in economic analysis. Explore the possibility of cooperation through continuous learning processes in the interaction of behaviors.

Most people who have not learned game theory use game theory in their daily life. We just use game theory to explain the problems encountered in real life. Game theory comes from the ordinary life, but so perfect and extraordinary, its extraordinary lies in the upgrade of human wisdom is the condensation of profound and thorough strategic thinking. The theoretical models of game theory can generally find their prototypes in real life, and many phenomena in reality can be condensed into game theory models. The application of game theory in life is exactly the embodiment of human wisdom and crystallization. It interprets the game from everyday life, chess to the cooperative innovation between enterprises in the development of the subject itself is also perfect, but also requires the game theory can be more toward the direction of evolution.

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