

An Analysis of the “Prisoner’s Dilemma” in the Theatrical Effect of Educational Predicament

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Abstract—“Theatrical effect” in behavioral economics is adopted to vividly interpret the “high-cost but inefficient” dilemma in the current Chinese education, and then the “prisoner’s dilemma” in game theory is used to analyze the educational dilemma. By introducing the discount factor, a finite and infinite prisoner’s game model are utilized to analyze the equilibrium of education dilemma. Considering the essence of the educational dilemma is the deviation between the individual rationality and the collective rationality, it is suggested to introduce the “punishment threat” and strictly implement the third party’s regulatory commitment.

Keywords—*Theatre effect; “Prisoner’s dilemma”; Education predicament; Discount factor*

I. INTRODUCTION

China has been advocating the reduction of burden and strictly prohibits the tutoring, but we still can often see news reports: the pupils cannot finish their homework even if they stay up late, middle school students have to go to school even if they have a holiday, and college students can’t bear the heavy pressure to jump the buildings. More tragically, when each student has paid more, their overall score is not significantly different from the previous ranking, which is clearly in a dead cycle.

Many scholars have paid attention to this phenomenon [1-5], and some scholars have analyzed this phenomenon in different angles, trying to find a reasonable way to solve it and get a lot of valuable conclusions [6-9], but there is no literature to combine this phenomenon with the theater effect. Therefore, it is worthwhile to look forward to the analysis of the current situation of education combined with theatre effects.

II. AN ANALYSIS OF THE THEATRICAL EFFECT OF THE PRESENT SITUATION OF EDUCATION THEATER EFFECT

A. Theater effect

What we have quoted here is the concept of theatre effect in behavioral economics: in a theater, everyone sits in his seat and watches the play. Suddenly, a man stood up. Everyone advised him to sit down because of his actions blocking the other audience, but he remained unmoved. As a result, the people around them were forced to stand up for the theatre, so the audience would sit up and watch the play on the chair. We can divide the theater effect into four stages.

Step1: everyone is sitting in the theatre.

Step2: a person stands up to watch the play;

Step3: all the people stand to watch the play;

Step4: everyone is standing on the chair and watching the play.

The final outcome of the theatre effect is that all people are more tired than they have seen before, but the income is not much more than before, which means that the people who destroy the order first have no long-term interests, and those who abide by the order have also become victims. Unfortunately, there are many shadow effects of theatre in China’s current education industry.

B. The effect of theatre in Education

Take homework as an example. In one school, teachers in some subjects have arranged more homework than usual in order to improve their students’ achievements. After a period of time, the teachers of other subjects found this method have significant effect and follow up. Gradually, the volume of work has been changed from easy completion to overloading. We divide it into four stages.

Step1: easy to complete the work of various subjects;

Step2: some subjects increased their homework and improved their performance in the short run.

Step3: all subjects added homework, and each subject's performance improved.

Step4: the job is increased to an unbearable range.

It is like a row of ordered series $\{a_n\}$, in the initial state: $a_1 < a_2 < a_3 < \dots < a_n$. When each element in a sequence increases by x , the value of the element changes, but the relationship between the elements remains unchanged: $a_1 + x < a_2 + x < a_3 + x < \dots < a_n + x$. However, after doing so much homework, all the teachers and students are more tired, and more importantly, students are tired of learning and are bored with school because of the amount of homework. The more demonized is: no one can stop. No teacher will reduce homework and no student dare to stop doing so much homework.

Initially, this phenomenon can be explained by the theatrical effect in behavioral economics. However, the theatre effect does not take into account that education is the result of Multi Strategy Interaction. Therefore, this paper will use the "prisoner's dilemma" from the perspective of game theory to analyze the educational dilemma.

III. AN ANALYSIS OF THE "PRISONER'S DILEMMA" IN THE THEATRICAL EFFECT OF EDUCATIONAL PREDICAMENT

For "prisoners' dilemma", many scholars have studied its characteristics and explored ways to get rid of "prisoners' dilemma" from different aspects [10]. The study of these scholars provides a reference to the methods used in the "prisoner's dilemma", but there is no literature to link the theatre effect to the "prisoner's dilemma", so this article will try it next.

A. "Prisoner's dilemma"

The general situation of the "prisoner's dilemma" is as follows:

The police arrested two suspects, but there was no sufficient evidence to accuse the two people to commit a crime, so the police separated two suspects in two different rooms for interrogation. In the face of the interrogation, two people have two strategies: {Frankly} and {Denial}, and both sides will eventually make their own choices based on the police's policy and the other's strategy, which can be seen as a two person zero sum game. The police's policy is known as follows: if two people are confessed, each is sentenced for 5 years; if two are repudiated and each is sentenced for 1 year; if one is confessed and the other is repudiated, the confession is released and the repudiated is sentenced for 10 years, and we have built a model like TABLE I.

TABLE I. THE GAME MODEL OF THE "PRISONER'S DILEMMA"

		B	
		<i>Frankly</i>	<i>Denial</i>
A	<i>Frankly</i>	<u>-5, -5</u>	<u>0, -10</u>
	<i>Denial</i>	<u>-10, 0</u>	<u>-1, -1</u>

Here we use the marking method to analyze. In A, for example, for personal reason, he will consider two strategies: when B chooses {Frankly}, A will choose {Frankly}, because the decision is more profitable; when B chooses {Denial}, it is clear that A will still choose {Frankly}. It can be seen that no matter what strategy the opponent chooses, {Frankly} is the dominant strategy of A. Similarly, {Frankly} is also a dominant strategy for B. Therefore, the dominant equilibrium strategy for "prisoner's dilemma" shown in TABLE I is: {Frankly, Frankly}.

From TABLE I, we can see that when A and B choose {Frankly}, their gains significantly higher than the benefit of the dominant strategy resulting from the individual rationality, which is the result of collective rationality, and also reveals the greatest predicament of the prisoner game: the decisions made by individual rationality is deviated from collective rationality. The dilemma is similar to the theatre effect and the current educational dilemma. Every audience in the theater wants to get a clearer view, and everyone in the education chain wants to do better, but the result is even worse.

B. The theater effect from the perspective of game theory

It is assumed that two viewers of X and Y are watching the theatre at the theatre, and they are both sitting in their own positions. When one person suddenly stands up, the other will make a corresponding strategy. The payoff matrix can be expressed in the model in TABLE II.

TABLE II. GAME MODEL OF THEATRE EFFECT

		Y	
		<i>Sitting</i>	<i>Standing</i>
X	<i>Sitting</i>	6, 6	2, 8
	<i>Standing</i>	8, 2	4, 4

By using the analysis method of TABLE I, we can conclude that the dominant equilibrium strategy of the theater effect model is {Standing, Standing}. As the supply of demand in economics, a change in one factor will lead to changes in other factors in the whole market, until the market reaches a new equilibrium so that demand and supply will return to the same state. When a person stands up to see a play and gets a good visual experience, other people will follow up quickly, which leads to the loss of the superiority of the first standing person, and there is no significant change in visual experience as compared with the beginning. At this time, however, all the audiences were more tired, and they paid more, but the result was not different from the original.

Next, we can use the marking method to analyze the formation of educational predicament.

C. The educational dilemma from the perspective of game theory

Before analyzing the formation of educational dilemmas, we also set up a game model of operation volume, as shown in TABLE III.

TABLE III. GAME MODEL OF JOB VOLUME

		English	
		Ordinary	Increase
Math	Ordinary	6, 6	2, 8
	Increase	8, 2	4, 4

We can still use TABLE I's analysis to get the dominant equilibrium strategy of the game model of operation volume: {Increase, Increase}.

In this regard, we have made clear the causes of the "prisoner's dilemma", and successfully used the "prisoner's dilemma" model to explain the causes and process of the education predicament. However, there is a certain difference between the two: prisoners can be kept in cages all their life, which is their responsibility for their improper behavior. But the students cannot always be plagued by their homework. Otherwise, it will also affect the future construction of the country, so we will use the method of solving "prisoner's dilemma" to find out the export of education predicament.

IV. THE GAME SOLUTION OF FINITE AND INFINITE TIMES

A. The solution of finite game

When the two person zero sum game between the player is limited to n, it is assumed that the discount factor in TABLE I is δ_1 ($0 < \delta_1 < 1$). Based on the premise of two persons' cooperation, we analyze them from the perspective of A. As a rational person, B will choose according to the change of A's strategy. In phase k, if A chooses {Denial}, he will be released under this policy, but his behavior will also trigger B never to cooperate as a penalty, this leads to A's revenue in the future is -5. Under this strategy, the revenue of A is $\pi_1 = 0 + 0 * \delta_1 + 0 * \delta_1^2 + \dots + (-5) \delta_1^{k-1} + (-5) \delta_1^k + \dots + (-5) \delta_1^{n-1}$, that is, $-5(\delta_1^{k-1} - \delta_1^n) / (1 - \delta_1)$. If A keeps cooperating and B will continue to cooperate, the revenue of A is $\pi_2 = (-1) + (-1) \delta_1 + (-1) \delta_1^2 + \dots + (-1) \delta_1^{n-1}$, that is, $\delta_1^n - 1 / (1 - \delta_1)$. If $-5(\delta_1^{k-1} - \delta_1^n) / (1 - \delta_1) < \delta_1^n - 1 / (1 - \delta_1)$, that is, $5\delta_1^{k-1} - 5\delta_1^n + \delta_1 > 1$, obviously when the discount factor δ_1 is large enough, the inequalities may be established, and the prisoner A is more inclined to cooperate and choose {Denial}. B is the same.

The same analysis: the models in TABLE II and TABLE III maintain cooperation only when the discount factor is greater than the critical value. Prisoners, spectators and students are still in a dilemma, so we need to further explore the solution to infinite games.

B. The solution of infinite game

When the two people zero sum game between prisoners is infinite, it is analyzed from the perspective of A. It is still assumed that B is a rational person, and the discount factor in TABLE I is δ_2 ($0 < \delta_2 < 1$). Under the premise of two individuals, in phase k, if A selects {Frankly}, then he will be released under this strategy, but this will cause A's revenue to be -5 in the future, then A's payoff is $\pi_1 = 0 + 0 * \delta_2 + \dots + (-5) \delta_2^{k-1} + (-5) \delta_2^k + \dots$, that is, $-5\delta_2^{k-1} / (1 - \delta_2)$. If A keeps on working together, B will insist on cooperation, and A's earnings will be $\pi_2 = (-1) + (-1) \delta_2 + (-1) \delta_2^2 + \dots$, that is $1 / \delta_2 - 1$. If $-5\delta_2^{k-1} / (1 - \delta_2) < 1 / \delta_2 - 1$, or $\delta_2^{k-1} > 0.2$, is met, A will choose and persist in cooperation. It is the same from the point of view of B. The two offenders are more

inclined to cooperate, because once someone has betrayed him, he will be betrayed in the next infinite game, and the result is a damage to his own interests.

Although in an infinite game, the player will cooperate in a certain range, however, the reality often does not exist such an infinite game, we can only use the finite game to find the solution of the "prisoner's dilemma". In the theater effect and the case of the homework, this game is obviously not exist, because people cannot always stand to watch the play, children cannot always be trapped in the homework cannot get off, so we may as well introduce the third party supervision department to help solve.

C. Third party regulatory authorities

Back to the "prisoner's dilemma" model in TABLE I, the finite game solution shows that as long as the discount factor is large to a critical value, the two prisoners can always maintain a cooperative relationship, which is converted to the actual case, that is, as long as the policy can maintain consistency, the easier it is to form a cooperation. If two prisoners enter the game, there is a rule that if anyone betrays, the betrayer will be sentenced to life imprisonment, so no one will dare to choose betrayal. The effect of theatre and the operation of education is also the same. As long as the supervision department of third parties is introduced and a credible mechanism of punishment is drawn up, once the theater order is destroyed, he will never be allowed to go to the theatre. Once there is an unreasonable educational pattern like an infinitely increased volume of homework in schools, the regulator will punish the teacher for leaving the education industry. It is believed that few teachers are risking their careers to make such a move. Therefore, as long as the supervision is in place and the system is perfect, this phenomenon will surely be improved.

V. CONCLUSION

Education has always been an important issue in the process of construction in China. However, education in China is facing the dilemma of "theatre effect". For this reason, this paper takes the problem of operation as an example, and analyzes the dilemma of education by using the "prisoner's dilemma" and "discount factor" from the point of view of game theory. First of all, we find the reasons for the theater effect from the source. Then, through the search for the solution of the prisoner's dilemma, and using the finite and infinite solution of the game and the analysis of the discount factor, we finally put forward the method of setting up the punishment mechanism by the third party supervision department, in order to guide the people in the finite game to feel the betrayal threat in the infinite game to get rid of the educational predicament. We are very clear that the formation of the predicament is the result of the Multi Strategy Interaction between the players. So, if the player can actively meet the supervision of the regulatory authorities, the education will get out of the dilemma as soon as possible.

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