Countermeasure Analysis on Free Rider Problem Based on Pig's Payoff Game

Yunxi Zhu*

Hangzhou No.2 High School of Zhejiang Province, Hangzhou, China

*Corresponding author: yy2784@tc.columbia.edu

Abstract. The free rider problem has caused many negative effects on the society, and then brought unfairness of distribution. In order to reduce the behaviour that contributing less but could gain more, this paper is going to find ways to solve the problem. The pig's payoff game is a good model as the big pig's behavior is cooperative and collective, but the small pig's behavior is non-cooperative which is suitable for the free rider problem. The final solution is setting up an applying reward and punishment mechanisms and a method of motivating individuals. The research results show that in order to apply the reward and punishment mechanism, another method focuses on motivating individuals, which means that group members are interested in making more contributions by influencing their incentives. These solutions will help to make people who work harder to gain more. And then improve the fairness.

Keywords: Game theory; free rider problem; pig's payoff problem; distribution of resources.

1. Introduction

1.1 Research Background and Motivation

The free-rider problem was firstly proposed by Mancur Olson, an American economist and sociologist, in his book The Logic of Collective Action in 1965. The basic meaning is to take advantage of others without paying the cost. Therefore, it's a public money problem. A person who needs public money but claims in advance that he or she does not need it, so that he or she can enjoy it unearned after others have paid for it. Free rides often result in inadequate supplies of public goods. Free-riding impedes the market's automatic regulation process. If the free rider problem cannot be solved perfectly, it will bring many negative effects. There are always some people to work hard, but other people to do things carelessly. Then it brings unfairness. Therefore, a successful ideology must be able to overcome the "free rider" behavior, which is a central problem of various ideologies. And ideology is a mode of behavior that makes behavioral decisions more economical by providing people with a "world view. Thus, the free rider problem will cause the unfair distribution of social resources. Returning to the reality, there are indeed many real-life examples of the free-rider problem. For example, small companies want to follow the big companies' innovation to spend less and the individual in the stock market wants to spend less time and money and just follow the financial organization's action to buy stocks. In order to deal with the free rider problem, this paper finds pig's payoff game to be the basic point. As there is a fundamental consistency between the pig's payoff game and the free rider problem, so using the pig's payoff game to find a solution to the free rider problem can be more efficient and faster. Effectively solving the free rider problem can increase social fairness, reduce the phenomenon of contributing much but gaining less, and promote social development.

1.2 Literature Review

In recent years, analyzing and considering the free rider problem, many researches had some constructive findings. Olson who firstly proposed the free rider problem had found two reasons that will cause the free rider problem, one is a collective reason and another is an individual reason. According to two reasons, he put forward the method conjecture to constrain the collective and the individual respectively. Then Johns-Boast, Davies, Hall and Buzwell had proved that the free rider problem would cause negative effect on education [1]. Their early studies had showed that students'

skills, productivity and the connection with the group were all limited [2]. Xiuyu Xie and Wenxing Zhao found three solutions to make the game more fairly [3]. One way is to reduce the food, one way is to increase the food and the last way is to change both the location of the food and the quantity of the food. The former two methods have limitations but the last one is more efficient to solve the problem. Additionally, according to some researchers, there are two useful solutions to solve the free rider problem. One is called the structural solution and another is called the motivational solution [4].

1.3 Research Framework

The structure of the paper is as follows: the first part is the introduction, the second part is the case description, the third part is the case analysis which compare the real-life examples and the pig's payoff game and try to find the reasons that cause such free rider problems, the fourth part is based on the results of the case analysis and the reasons behind the discussion and suggestions, and the last part is the conclusion.

2. Case Description

In economic system, "the smart pig game" is a kind of game theory. The game is about two pigs to compete food. There is a little pig, a big pig and a button in pigsty, and a feeder with ten shares in the opposite of the pigsty. Both pigs can choose to press the button or not. Each pig should pay two shares if it wants to press the button. If two pigs press the button at the same time and run to the feeder the big pig eats seven shares and finally gets five shares, and the little pig eats three shares and finally gets one share; if the big pig presses the button and runs to the feeder, the big pig eats six shares and finally gets four shares, and the little pig eats four shares and finally gets four shares; if the big pig waits and the little pig presses the button, the big pig eats nine shares and finally gets nine shares, and the little pig eats one share and finally gets minus one share; if both wait the payoff is 0 [5]. After analyzing, this paper can find the Nash Equilibrium only exists when the big pig presses the button and the little pig waits. In the real life, there exists some vivid examples. The initial "the smart pig game" has a classical model in economic, which is called "free rider problem." In the pig's payoff, the Nash equilibrium was for the big pig to press the button, and the small pig just to wait for the food, the results of the game are shown in Table 1.

Table 1. Game matrix

player	small pig		
big pig		press the button	wait
	press the button	(5,1)	(4,4)
	wait	(9,-1)	(0,0)

The game player with non-cooperative characteristics has a greater payoff in the pursuit of their own interests than the game player with cooperative characteristics. In other words, the "waiting" action of the small pig suggests a free-rider problem, which is the dominant issue that happened in this game. There are always participants who didn't pay their fair share for the result. For example, small and medium-sized enterprises are always considered as free riders as for they have poor ability to research and develop innovation [6]. So, they are willing to follow the big companies as free riders. Moreover, in the stock market, there are financial institutions or large individuals with large amounts of capital and stocks and retail investors who do not have sufficient funds to invest in the early preparation, nor do they have rich and effective information resources to provide services for their own decision-making, let alone the ability to operate the market on the stock speculation. So, the best way to make money is to follow the big players and organizations. In addition, in the company, there is boss and staffs. In this situation, the boss can be considered as big pig, because boss can get more benefits as an employer. The staffs can be considered as little pig, as for they can only get the fixed

salaries. And the action “press the button” is whether to work hard in the real life. Because of such reasons, boss will work hard to gain more benefits but staffs are not willing to work hard.

3. Case Analysis

These are also strong evidences that people exploit free-riding opportunities in voluntary cooperation games. Early studies tried to find negative impact of free-riding in group work on education quality. The final results showed that when the group exited free-riding behaviors, the skills and content the groups should have acquired were limited; the productivity was fallen; and the actual workplaces would also happen undesired free-riding behavior [2]. Also, hard-working group members who are DE-motivated and influenced by free-riding behaviors may reduce their contributions to the group work and feel disappointed [2]. Thus, free-riding has the potential of affecting both the free-riders and capable group members as well [2]. According these researches, the free rider problem exactly has many negative effects. Before finding the efficient solution to deal with the free rider problem, this paper will first analyze its basic logic. A free rider is an individual who gains payoffs from accessing a public resource, but does not contribute during the process [7]. According to this characteristic, there are two reasons that cause the free rider problem [8]. The first one is the group that lacks supervision and control over individuals, and the second reason is the individuals all want to maximize their benefits [9]. If uses “the smart pig game” to explain, it means everyone wants to be the little pig. For the society, because the piglet failed to compete, the allocation of social resources when piglet hitchhiked was not the best state. For the most efficient allocation of resources, the designers of rules do not want to see free riders, and neither do governments nor corporate bosses. And can completely eliminate "free rider" phenomenon, depends on the rules of the game core indicators set is appropriate.

4. Suggestions

There are three solutions to make the game more fairly [3]. The first one is to reduce the food. If there is only half as much food as before. If little pig presses the button, big pig will eat up the food and if big pig presses the button, little pig will eat up the food. The result is that little pig and big pig don't press both. It means that whoever presses the button will contribute food to the other side, so there will be no incentive for anyone to press the button. Obviously, it is not a good solution. The second one is to increase the food. When there is enough food for both big pig and little pig, they will all press the button. Because whoever waits always loses the opportunity to get enough food. It seems to be a good solution, as for both pigs can get enough food and contribute the same. But there still has the problem that this method requires the designers to cost much more. Despite of changing the quantity of the food, moving the position of the feeder is also a good choice. So, the last idea is to reduce the food and move the feeder closer to the button. Given only half of the food, but move the feeder near the button. As a result, the little pig and the big pig are fighting for the button. It who waits will eat nothing, but it who works hard will gain much. This method associated the contribution of each pig and the payoff each pig gains.

Overall, the third solution is the most viable way to solve such problem.

Building on the pig’s game, the paper will give some solutions about real life’s problems. According to some researchers, there are two useful solutions, structural solutions and motivational solutions [4]. One of the structural solutions is called “mutual restriction” [10]. In other words, it is called the applying reward and punishment mechanisms. Research had tested the method’s effectiveness. The research examined the characteristics and relative strength of third-party sanctions in a series of experiments [11]. The experiments showed that third-party punishment were powerful tools for the society [11]. The structural solutions are usual norms for the whole team. And the motivational solutions usually focus on motivating individuals which means through affecting the incentives of group members to make it their interest to contribute more [11]. The structural solution

is the real life's solution of the second method that providing enough food of "the smart pig game", and the motivational solution is the real life's example of the third method that reducing the quantity of the food and moving the feeder in "the smart pig game".

5. Conclusion

As the free rider problem has been proved to have many negative effects on various fields, the core of this paper is to find some effective ways to solve the free rider problem. The free rider problem is caused by the immaturity of collective rules and the selfishness of individuals. Based on these, the free rider problem will bring the unfairness of the distribution of the resources. So, dealing with the free rider problem is necessary. Firstly, the examples of free-rider problem existing in reality are analyzed, which will help to further understand the free rider problem. And then the pig's payoff game is compared with the free rider problem as they have the same basic logic. The analysis is carried out with the pig's reward game as the entry point. This paper started at finding the Nash equilibrium of the game theory which happens when big pig contributes to press the button and little pig does nothing but gain the same food as the big pig. And then, this paper finds the reasons leading to little piggy's unearned gains are found. After completely analyzing the pig's payoff game, this paper back to the free rider problem. Considering about the collective reason and the personal reason, combined with the reality, this paper gives hypothesis and some feasible solutions. One is called the applying reward and punishment mechanisms and another solution focus on motivating individuals which means through affecting the incentives of group members to make it their interest to contribute more. In order to develop the fairness in the society, both free market and government should pay attention to the free rider problem. Additionally, this paper also has many limitations. How to set up the applying reward and punishment mechanisms is still a big problem and it is uncertain whether the method of motivating individuals will work for everyone. In the future research should focus on improving existing methods, finding more effective methods, and reducing individual selfishness by increasing the moral sense of society through education.

References

[1] Rui Yang, On the motivation of individual behavior in the free-rider problem, Law school, Nanjing Audit University.

[2] IAC Paper, Grossman, Hart, Paper I, Grossman, Hart. 2. The free rider problem. URL: https://www.tau.ac.il/~spiegel/teaching/corpfin/Topic6.pdf, last accessed 2023/1/24.

[3] Timothy Ketelaar, Emotional Solutions to Free Riding:01 January 2021.

[4] Xie Xiuyu, Zhao Wenxing Research on incentive mechanism based on "smart pig game", Value Engineering, 2013, 32 (34): 2

[5] Ge Qu The application of game theory in the design of enterprise incentive mechanism -- based on the research of "smart pig game" model President, 2009, 000 (004): 11.

[6] Xiao Jiabiao, Jin Yan Application of multi-objective game optimization method in engineering design Jilin Agriculture: Academic Edition, 2012 (4): 1.

[7] Ernst Fehr and Klaus M. Schmidt, A Theory of Fairness, Competition, and Cooperation: The Quarterly Journal of Economics, 1999, 114 (3): 817 - 868.

[8] Abate Demissie Gedamu: Secondary school teachers' management and assessment strategies of free-riders in group work: implication for engaging the disengaged: June 2022.

[9] Ernst Fehr. Third-party punishment and social norms, Institute for Empirical Research in Economics, University of Zurich, Blümlisalpstrasse 10, CH-8006 Zürich, Switzerland: Received 2 July 2003, Accepted 28 January 2004, Available online 9 April 2004.

[10] Zena Huang, The inspiration of "boxed pigs" to the innovation of small and medium-sized enterprises, Guangdong Industry Polytechnic.

[11] Ting Guo, The role and mechanism of social punishment in free-rider problem, Northeastern University China, 2020.