How the expanded crowd-funding mechanism of some southern rural areas in China affects cooperative behaviors in threshold public goods game

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ABSTRACT

The pursuit of high cooperation rates in public goods games has attracted many researchers. However, few researchers attach much weight to the influence of emotions on decision-making, especially on public goods games. From ancient to modern times, publishing the list of cooperators to stimulate cooperation has been a common phenomenon in some southern rural areas in China. Actually, the published list can influence individuals' behaviors by affecting their emotions. Here we extend the method of publishing the list and optimize it by adding a lobbyist mechanism. Through numerical simulations, we find that the role of lobbyists can not be ignored unless the synergy factor is larger than a certain value. Additionally, we find that publishing the list certainly has a great effect on individual's cooperative behavior. But whether to publish the list or not and how to publish the list depend on the situation.

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1. Introduction

At present, the problems we have encountered can be summed up for the contradiction between the collective interests and individual interests. Cooperation means that people have to contribute personal interests to others, even may help the potential competitors. However, there is no doubt that cooperative behaviors are universal in reality. Therefore, how to promote cooperation in real word become an important and challenging issue [1–3]. In recent years, great progress has been made in the analysis of cooperation from the perspective of evolutionary game theory. The prisoner's dilemma (PDG) is a representative example of non zero-sum game which describes how two rational individuals choose their own best strategies, but not the best choices for groups [4]. In real life, however, most conflicts often occur in muti-agent groups. The public goods game (PGG) is a standard of experimental economics which is mainly used for analyzing the multi-person group. In this model, each individual can secretly make decision that whether to contribute their private property or not to the public pool. Then, the payoff of public goods will be divided among players evenly. Defectors would benefit from this rule. Thus, it will cause some popular problems, like the tragedy of the commons and the free rider [5–8]. Due to these issues, many researchers are making great efforts to explore mechanisms to solve these dilemmas [9]. Punishment mechanism is proposed by many researchers [10–18]. Through this method, defectors will be added cost by penalty. Considering their own profit, they would choose cooperative strategy. The reward mechanism, which is contrary to the punishment mechanism, is also received widespread attention from researchers [19–22]. Due to the existence of indirect reciprocity, a lot of people choose to cooperate in order to get a better reputation. Therefore, reputation mechanism is introduced into the PGG to promote cooperation [15,23–25]. However, the punishment mechanism and reward mechanism are not available when it's failure to identify defectors [26–30]. Besides, many researchers also have studied the influence of the group's own attributes (like group diversity, group size, group heterogeneity, agents' ability of thought independent, etc) on the game of public goods [31–38]. What's more, many other mechanisms have been explored, e.g., insurance, the religious belief, the establishment of institutions, the tolerance toward defectors, etc. [1,39–41]. Mechanisms above mostly have tended to emphasize the operation of analytic processes in guiding cooperative behavior. However, bounded rationality, somatic marker hypothesis (SMH) and many other economic models emphasize that we can not ignore the role of emotions in decision-making [42,43]. Nowak also has pointed out that each person's emotion would be affected by the network of friends and loved ones, etc [44]. According above, it is worth digging much deeper in the cooperative field of the public goods game.

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Culture is playing a more and more important role in people's life. However, the increasing demand of spirit and culture can not timely and efficiently to be met in many areas, especially in rural region. If we can motivate social forces to improve the effective supply of public cultural products, it will not only light the burden of government, but also provide lots of products with high quality. Therefore, how to encourage people to contribute their own interests to provide basic, even higher quality public cultural products, is a significant topic.

Here, we propose a model to attempt to solve those problems. Actually, providing public culture goods through crowd-funding has been around for a long time in Chinese history. The most typical example is the providing of village opera in most southern China. The annual village opera fees come from village committee and resident's donation. The donor's name will be published. Publishing the list has effects on cooperation mainly because of its effects on individuals' emotions. Thus people's decisions will be influenced by the list. In fact, this is a traditional way of providing public cultural goods in china. Since it is still in use, it indicates the antiquity of the tradition. Of course, it also has its drawbacks. Therefore, we want to expand and optimize it in a scientific way to solve modern social dilemma. Although PGG is considered to be one of the most common games in the study of social dilemmas, it can not be suited to every social dilemma [45]. Therefore in this paper, we use the so-called threshold public goods game (TPGG), which means public goods will be provided only when the contributions are equal or exceed the required threshold [39,46,47]. But if the group contribution can not reach the certain threshold, the contributions will not be returned to the cooperators.

We divide people into three types, namely, the unconditional cooperator (UC), the unconditional defector (UD) and the slick free rider (SR). Cooperation is one of the most basic human instincts [44]. Therefore, we have reason to believe that all people have the impulse to donate money to build public goods. If the donation exceeds the threshold, the extra contributions will be a significant role for much more effective public culture goods [1]. In a sense, it also may be beneficial to provoking humans' good nature. And then we apply the way of publishing the list to modern public goods games. In our view, the influence of emotions on cooperation behavior can not be neglected. However, modern economic theory always ignores the influence of emotions [42,43]. Our aim is to increase cooperation level through the full use of people's emotions. Therefore, besides making full use the list, we also set up a type of person called lobbyist. They will influence individual's emotions through words. Therefore in this paper, we focus on examining the importance of the role of lobbyist, and observing how to publish the list is the best.

2. The TPGG model with three types of agents

In our TPGG model, we consider the evolutionary public game on a $L \times L$ square lattice with periodic boundary conditions and von Neumann neighborhood. There are three types of players (UC, UD, SR) who are all randomly distributed on the square. In order to express convenience, we use a_1, a_2, a_3 represent the proportion of UC, SR, UD, respectively. Whereas every UC contributes an amount ($c = 1$) to the public pool, UDs and SRs contribute nothing but exploit cooperators' efforts. That is, everyone in the group can enjoy the public goods fairly. Here, we assume that $a_1 > 0$, because it can conform better with the reality. What's more, it has been confirmed that a minimal number of cooperators is required to elicit the full advantage of group [48]. Please note that lobbyists derive from the UCs. That means lobbyists are all UCs, but UCs are not all lobbyists. Some UCs have the lobbying power because they have accumulated reputation in the previous cooperation or have special status. Nevertheless, some of those UCs are willing

to spend their time and energy to act as lobbyists but some are not. Therefore, the proportion of lobbyists is really small. In addition, every people in the group all has emotion and rationality. Different people, however, are different in their ability to control their emotions. Unlike SRs, UCs and UDs are strong-minded. UCs are sure that they should cooperate and UDs are totally do not want to cooperate any more at the first time. Therefore, the published list and lobbyist's emotion words seem have little effect on them. But it is a fact that individuals, whether humans or animals, will have different behaviors in different situations [49]. Whether or not to adopt a different strategy depends both on the personal success of each individual and on the strategies of neighbors [50]. Therefore, SRs and UDs also may change their strategies. SRs could also be called conditional cooperators. That is, although SRs have the impulse to donate money, they are always hesitant for various reasons. But SR's emotion will be influenced by the people around (like a neighbor's decision, lobbyist's emotional words), then their desire may be aroused. This may lead them to make relatively irrational decisions. Because they think the payoff will not be very low if doing this. This is also very similar to the conformity [51]. In addition, SRs and UDs also may change their decisions based on the payoff of their neighbors. In other words, SRs are the combination of conformity-driven players and payoff-driven players. And UDs are all payoff-driven players. They are good at making decisions according to situations. In addition to exploring the role of lobbyists, we also need to study whether and how to publish the list is better. Therefore, we here propose two different models.

Model 1: The whole evolution process is a dynamic circulatory process. Each stage has two parts: SRs' emotions are passively influenced by others and both SRs and UDs try to maximize their payoff through actively imitating others' strategies. At the first part of each stage, UCs' and UDs' names will be published. Meanwhile, a Lobbyist also try their best to persuade a SR to cooperate. Thus, the total influence to a SR's emotion from outside can be summed over as follow:

$$N(t + 1) = (1 + nA - mB + xC - yD + zE)N(t)$$

Where N denotes the agent's emotion. A stands for the positive effect from the cooperated neighbor. B means the negative effect from defector. C denotes the influence from ex-SRs. D is the negative effect from SRs. E signifies the positive effect from lobbyists. We call A, C, E emotion promotion coefficients, call B and D emotion inhibition coefficients at the same time. Different people will have different affection degree to the SR: the UC's and UD's decisions have less influence power than the decision made by SR. This is because people always like to analyze those who have the same features as they have, and are used to make some comparisons with them as well. Actually, this kind of phenomenon is very common, projection effect and availability bias are more or less related to this phenomenon. That means everyone can project their own characteristics to others, more attention will be provided to those people who have the same characteristics with themselves. Therefore, the ex-SR who used to be a SR now has become a cooperator has more influence power relatively ($C > A$, $D > B$). Compared to the published list, lobbyists can pertinently persuade the SRs by persuasive language. Furthermore, it has been confirmed that people always become more generous and benevolent when they feel that they are under the gaze of others[44]. Therefore, the lobbyists not only can influence others through words, but also can act as such an observer. Thus, the lobbying effect is always the best.($E > A$, $E > C$). Because cooperation is one of the most basic human instincts and people's nature at birth is good, we here assume that the emotion promotion coefficients are always larger than emotion inhibition coefficients.

The lowercase letters (n, m, x, y, z) represent the number of people in each of the categories in the neighborhood. And every-