Research on Institutional Invalidation Caused by "Potential Rules"

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Abstract. Through the simulation study of multi-equilibrium game with "Potential Rule" strategy, we find that the behaviour of "Potential rule" can be evolved through repeated game without considering any other social preferences of the subject and any prior knowledge of the game. This paper will analyse the endogenous evolution of the third strategy, namely the "Potential Rules", between the choices of fair and unfair strategies from the perspective of interest transmission. The experimental results show that the subjects who own the third strategy with the characteristics of "Potential Rules" will spread to other subjects in a certain institutional environment by imitating learning and adjusting strategies. The third strategy will become a guide to the behaviour of the subjects and form a deviation of the institution, which will lead to institutional failure.

1. Introduction
Human trading behaviour depends on the ratio of transaction income to transaction cost, and a series of rules and orders that regulate and guide trading behaviour are called institutions [1]. From the perspective of game theory, Aoki Masahiko regards the economic process as the game process, and regards the institution as the equilibrium strategy of the game that participants play under certain game rules [2]. Only when a strategy is chosen by most of people or everyone and becomes the will of the majority, the institution can be formed and will be recognized and observed by most or almost all members of society [3]. A good institution can fully reduce various transaction costs and maximize the efficiency of transactions. But in reality, not every institution is optimal. Like some formal institutions, it may be effective when designing, but with the development of society and the change of environment, it will become ineffective or inefficient. In order to cater to the real needs of society without contradicting the formal institution, there is an unwritten "rule" that prevails and prevails behind the formal institution stipulated by the state. It is not a formal official rule but dominates real life. Mr. Wu Si called it "Potential Rules" in the book "Potential Rules - Games in Chinese History". In fact, in every period of history, there are many people who are not satisfied with the formal institutional rules, and a large number of behaviours is carried out through illegal means, so that the institution is actually overhead, which in turn leads to the failure of the institution [4].

After the 19th National Congress of the Communist Party of China, China is currently in the stage of deepening the gradual rule of law. Xi Jinping believes that on the basis of the significant improvement of the rule of law environment and the formation of a fair and just social atmosphere, the construction of China under the rule of law will be accelerated and the environment under the rule of law will be improved. The “Clear Rules” will break the “Potential Rules” and accelerate the establishment. When people who choose to abide by the "clear rules", that is, people who choose formal institution increase,
then people who are related with him will also obey the "clear rules". When such a way of doing things becomes a habit, “Potential Rules” will disappear. However, the formation of "Potential Rules" is the same. In society, we usually learn a better strategy in the simplest way, that is "imitation learning." Edward Cartwright (2007) found in experiments that participants can imitate and better learn the benefits of different strategies and provide sufficient conditions for Nash equilibrium to appear over time [5]. Then, whether people will deviate from the original system and create a new system through imitation learning and whether "Potential Rules" can become people's behaviour guide through private trading behaviour are content of our studies. Evolution of "Potential Rules" is the focus of this paper. According to the "Potential Rules" transaction model, this paper designs the propagation and diffusion model of "Potential Rules" to study the endogenous evolution process of the institution. The main contents of this paper are as follows: Section II constructs the "Potential Rules" model of private interest transmission; Section III builds the simulation model and analyses the simulation results; Section IV summarizes this paper.

2. Basic model

2.1. "Potential Rules" model
In real economic activities, we have found many examples of "Potential Rules", such as the phenomenon of "counterfeiting" in sports competition; the phenomenon of red packets in medical systems; the phenomenon of school fees for primary and secondary school students; and the immigration of college entrance examinations. Among these phenomena, we have found that the two players have chosen one kind of behaviour more and more consistently through the interest transmission. Their common feature is that it is not a normative regulation or formal institution that guides our behaviour. It is a rule that is spontaneously formed and deviates from the formal institution and is not open to the public. Combining objective payoff matrix in game theory, we set the A2 strategy to make a certain gap between the two players of the game in order to introduce the unequal payoff of the two players of the game. In contrast, the A1 strategy is fairer than the A2 strategy, that is, the two players have equal payoff. Through the parameter U, the benefit of both players of the game can be transmitted. Here, the U can be money, or it can be an item of equal value with money, power or the way of the world, etc. Through the profit of the game player 2, two players both promote themselves to get more payoff than choosing A1 strategy. Good return value, that is, need to satisfy 4-U is greater than or equal to 2, 1+U is greater than or equal to 2, so the value range of U is [1, 2]. When player 1 or player 2 use the A3 strategy, another participant chooses A1 or A2, their payoff both will be impaired. That is, when one chooses to use the strategy of “Potential Rules” and another person does not use such a strategy, one player who chooses the “Potential Rules” strategy will have a certain loss because the other player does not use the "Potential Rules" and he wants to sacrifice some of the benefits. On the contrary, the player who does not use the "Potential Rules" strategy will have a certain loss because others choose the "Potential Rules" strategy. As a result, when one player chooses the "Potential Rules" strategy, and another does not choose, the payoff of both players will decline. Therefore, when we determine the payoff of strategy combination (A3, A1), (A3, A2), we calculate the corresponding payoff value with the expectation of 50% of the respective payoff of the corresponding column. The same is true for calculating the payoff of strategy combination (A1, A3), (A2, A3). A3 is the strategy that both players try to explore. If both of players don't agree with the options of “Potential Rules”, or reach a tacit agreement, or communicate with each other, and fights for themselves, then we suppose that they each have a 50% probability to choose A1 and A2. The objective payoff matrix of the game is shown in Table 1.
2.2. The main idea of the model
The main purpose of the model is to explore the diffusion conditions of the "Potential Rules" strategy. The main idea is that subject interacts with subjects who have different types through imitation learning without knowing the objective payoff matrix of the game. In the process of learning and imitating the same type of subject, subjects learn better strategy to make it more profitable. At the beginning of the game, the game participants' strategy set has only two strategies, namely A1, A2. With the exploration and learning of the "Potential Rules" strategy, whether subjects can learn the "Potential Rules" strategy or not and whether "Potential Rules" strategy become a better strategy chosen by most of subjects or not have become a study of the endogenous evolution of institutions.

2.3. Specific simulation design
According to Multi-Agent simulation theory and game learning theory, this paper assumes that the subject is bounded rational. According to social psychology and cognitive theory, imitation learning plays an important role in individual self-development and knowledge construction. The learning theory is the theoretical basis of this paper, and the game model of multi-agent imitation learning and exploring the "Potential Rules" strategy is established.

We use the theory of spatial game proposed by Nowak and May (1992) to build a model by using Swarm Multi-Agent simulation platform [6]. At the initial moment, agents are randomly distributed in a 100×100 two-dimensional space of a specific topology. We assume that both players in the game do not know the payoff in the objective payoff matrix of the game. In addition, every subject only knows its own set of strategies and does not understand the set of strategic actions of other subjects. In the process of the game, both players of the game choose their own strategies, and computer system will return the corresponding payoff value, which is selected according to the strategies of both players. This process will be repeated many times, and players will choose the strategy according to its own last round of payoff. In the model, each agent has its initial strategy and strategy is generated in a random manner. In each subsequent cycle, each agent plays game with its eight neighbours (as shown in Figure 1) who have different type and gets the average payoff (1) after the game. In the model, all Agents randomly walk around in order to simulate the social environment better, and then move on to the next cycle. Repeat this way. After each round of game, all agents update their strategies by learning the strategies of the highest-yielding neighbours, but they will not all succeed in learning the strategy of this neighbour. Every individual will think whether to change original strategy, so we use The Boltzmann distribution function (2) based the difference between one agent and the highest-yielding neighbo is used to calculate the probability of successfully learning the highest neighbours. The probability of learning depends on the difference between the two agents’ payoff, that is, the probability that the individual i learns the strategy of the individual j. We generate a random number R between [0, 1] in the model, and then the strategy of the subject with high payoff is successfully learned when \( R < P_{ij} \). When \( R > P_{ij} \), the subject maintains the original strategy.

\[
W_i = \frac{\sum_{j=0}^{n} P_{ij}}{n} \quad (1)
\]

\[
P_{ij} = \frac{1}{1 + e^{-\frac{P_i - P_j}{\kappa}}} \quad (2)
\]
As the game progresses, the subject gradually understands the benefits of strategic behavior and forms a stable strategy choice through repeated games. In order to explore whether the "Potential rules" strategy can be spread, that is, whether A3 can replace the other two strategies as the dominant strategy. In the simulation model, we define a small initial ratio to explore "Potential Rules" strategy and set its value to 15%. Then, through the above-mentioned imitation learning model, the convergence of the strategy is observed under different value of U.

3. Concrete model simulation results and analysis

3.1. Distribution of game subjects
First, we set value of U to 1.5. In the initial stage of the game, half of subjects choose the relatively fair strategy (A1) and the other half choose unfair strategy (A2), and each agent has 15% probability to choose the unknown strategy, the "Potential Rules" strategy (A3), after the first round. Figure 2 shows the distribution of the subject on the two-dimensional grid. In Figure 2, the small blue squares (the deepest color in black and white printing) represent the agents who choose the "relatively fair" strategy; the small red squares (the second deepest color in black and white printing) represent the agents who choose the "unfair" strategy; the small yellow squares (the lightest color in black and white printing) represent the agents who choose the "Potential Rules" strategy. Because the learning model of this paper is imitation learning, the subjects are clustered and the agents of the boundary are “invaded” to the subjects using different strategies. At T=10, we can find the A1 and A2 strategies each accounted for half. As the players randomly walked around and began to interact, the A3 strategy began to spread and successfully “invading” the groups using the A1 and A2 strategies. When the simulation went to 300, the A3 strategy has been learned by all the subjects. The simulation explains that the "Potential rules" strategy has spread through learning and interaction.
3.2. Strategy selection of the game subject

As shown in Figure 3, the number of people who choose a relatively fair strategy increases at the beginning of the game. This phenomenon reflects fairness preference of the public. Then the number of people who choose unfair strategy is relatively reduced. The reason for this is that if the player 2 chooses A2, his payoff is only 0 or 1. And if player 2 selects A1, he will get 0 or 2, so player 2 will tend to choose A1. In order not to make his own payoff 0, then player 2 will choose A1. With the subject's cognition of the "Potential Rules" strategy getting better and the choice of A3 making subjects more benefits, the number of subjects who choose A3 strategy rises rapidly while the number of subjects who choose A1 or A2 strategies declines. And all subjects finally form a stable strategy choice. The "Potential Rules" strategy is superior to other strategies and has become the common choice of the subject, reflecting the process of the endogenous evolution of the institution with the process of simulation.

![Average count of the player over time](image)

Figure 3. Frequency of Agents’ Strategy

The subject chooses the strategy according to probability every time, which is random, so the single simulation cannot explain that all subjects will only choose the "Potential Rules" strategy every time when the parameters are unchanged. We carry out three rounds under different U values, 20 times each round. Repeated simulation is used to observe whether the strategy of "Potential Rules" can become a common choice under different objective payoff matrices through imitation learning.

| U value | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| A1      | 3   | 0   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   |
| A2      | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 2   |
| A3      | 16  | 19  | 18  | 20  | 20  | 20  | 20  | 20  | 19  | 18  | 16  |

Table 2. Convergence of subjects under different U values (First round).

| U value | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| A1      | 2   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 2   | 2   |
| A2      | 1   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 2   |
| A3      | 17  | 18  | 19  | 20  | 20  | 20  | 20  | 19  | 17  | 16  |
Table 4. Convergence of subjects under different U values (Third round).

| U strategy | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| A1         |     | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 2   |
| A2         | 1   | 2   | 1   | 1   | 0   | 0   | 0   | 0   | 1   | 2   | 1   |
| A3         | 16  | 17  | 18  | 19  | 20  | 20  | 20  | 20  | 18  | 17  | 17  |

From Table 2-4, we can see that in most cases that value of U is between 1 and 2, the "Potential Rules" strategy can be learned by all subjects. And we can further find that when the value of U is between 1.4 and 1.7, the phenomenon of the subject choosing the "Potential Rules" strategy is very stable. All subjects choose the "Potential Rules" strategy and no subject choose the original strategy A1, A2, so a new institution was born.

4. Summary
In a specific institutional environment, when the subject predicts that he can get more benefits by not observing the contract, the "Potential Rules" behaviour will occur. When most of people choose to do things through "Potential Rules," then the formal system No one will follow it, then it will face the risk of failure. The "Potential Rules" will spread through the attempts and learning of the actors, but its existence undermines the existing order of the society, causing many legal loopholes, affecting social fairness, and making the authority of the law questionable. Therefore, on the one hand, this study reflects the possibility and speed of the diffusion of the "Potential Rules" strategy, and on the other hand reveals the process of the endogenous evolution of the institution.

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