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Game Analysis of "Officials and Peasants" – Taking Ephedra Sales License as an Example

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Abstract: China's rural issues are very complex. By introducing game analysis to further simplify the analysis, some problems can be gradually analyzed and studied in depth. Our team discovered some problems and interesting economic phenomena in the process of social research. These are the conventions formed by local residents. There is a game between villages, and there is also a game between farmers and the government. This article starts with a simple example of ephedra sales license. Under the condition of complete information, it is found that the economic scale of the village will affect the result of the static Nash equilibrium analysis. By introducing the proportion of young people in different villages and conducting dynamic analysis, it is found that the villages with a large economic scale are all villages with a high proportion of young people. Suggestions for the design of government mechanisms are given: We should pay attention to the education of young people and the human capital investment of such people.

Keywords: agriculture; game; human capital; proportion of young people

JEL Classification: C72; J24; O18

1. Introduction

China's nationwide system concentrates its efforts on major issues. But how to coordinate the two hands of the government and the market? China's agriculture, rural areas and farmers have always been troubled by the political and economic issues of our country? How to design a reasonable system to unblock information channels so that the Chinese government and farmers can achieve a positive-sum game?

On the occasion of the 100th anniversary of the founding of the party and China has just achieved a complete fight against poverty. In order to gain a deeper understanding of the current situation in China's rural areas, the School of Economics and Management organized a summer survey of the "Three Going to the Countryside". The theme of our team is: Ecological Compensation Mechanism and Rural Revitalization Research.

Our team went to Yanchi County, Ningxia to conduct household surveys. During the survey, some problems and interesting phenomena were indeed found. One of them is the problem in the process of planting and selling ephedra.

Village A in Yanchi County is delineated by the state for returning farmland to forests and ecological compensation. Because of the lack of water in the area, the crops are susceptible to the weather. The so-called farmers said that in the past, growing crops depended on the sky for food. Like this year, it hasn't rained for a long time. If you grow crops, there will be no

harvest. The farmers collectively should plant ephedra. They feel that planting ephedra can escape poverty, because ephedra requires less water than crops and is not affected by drought as much. Moreover, ephedra has a good market as a medicine. So, everyone basically changed to planting ephedra. But ephedra is still a kind of drug, so the sale of ephedra is subject to government control. A license must be issued to sell. I heard from the head of Village A that in the process of selling ephedra from place B to place C, the quality of the ephedra from place B to place C is weighed, and then re-scaled at place C. The quality difference cannot exceed a (the specific figures are forgotten, but the impression is the sale of ephedra is strictly controlled, and it cannot be stolen during the sale to prevent it from being sold as a drug to win huge profits). The government-controlled ephedra can only be used as a pharmaceutical ingredient.

We have learned that farmers, the supply of farmers is more than the amount of license sales. The village chief also hopes that the government can allocate more for them? Is this a problem? The market demand exceeds the quantity supplied by the license? The amount supplied by farmers exceeds the amount sold by license? How to coordinate the government's supervision and the market? How to design an effective system to deal with the differences between the government and farmers? For these problems, establish a game model for in-depth analysis to obtain reasonable results.

The following arrangement is as follows: The second part is a literature review on the application of game theory in institutional economics; the third part abstracts the establishment of game models for analysis; the fourth part draws conclusions based on the results obtained in the third part and puts forward relevant policy recommendations.

2. Literature Review

In order to find the connection point between institutional economics and game theory more clearly, this part first combs the main development process of institutional economics and game theory respectively, and then comprehensively analyzes how game theory is applied to institutional economics, and finally a few examples are reviewed to understand in more detail how game theory is applied to institutional economics.

2.1. The Development of Institutional Economics

System refers to the rules in interpersonal communication and the structure and mechanism of social organizations. Institutional economics studies the impact of institutions on economic behavior and economic development, and how economic development affects the evolution of institutions. Institutional economics originated from the "Leisure Class Theory" by American economist Van Buren, known as the old institutional school, which mainly examines people's behavior from the social culture and social scale of people's lives. Its main research methods adopt historical induction method and historical comparison method.

The explanation of economic phenomena further developed the new institutional economics, which originated in Coase's "The Nature of the Firm", introducing the concept of transaction costs into economic analysis, and pointing out the different roles of firms and markets in economic interactions. Steven N.S. Cheung 's "Tenant Farmer Theory" is regarded as a powerful interpretation and expansion of Coase's institutional economics, critical analysis

of the "rent value" theory, and correction of the previous misjudgment of the share system. Stiglitz's mathematics of Coase's theorem, standardization clearer dissemination and effective promotion of the theory. Among them, Stiglitz is also regarded as an important representative in information economics. In the new institutional economics, one point is very important, and the Coase theorem is the core of it. The simplest Coase theorem is: "When the transaction cost is zero, no matter which party the property rights are defined to, the Pareto effective solution will be obtained through the market transaction." A further promotion of the Coase theorem is that the transaction cost is not zero. How to solve externalities? The economic behavior between people will affect each other, and the participants will make their own optimization and conduct game analysis. Williamson, Demsetz, Hart and others have made important contributions to the new institutional economics.

Coase's pioneering achievements in the research methodology of institutional economics had an important impact on the later studies of economic history by North et al., the discussion of contracts by Zhang Wuchang and others, and the understanding of organizations by Williamson and others. They start from the actual economic situation, test the rationality of the theory, and emphasize that if the theory does not conform to the reality, the theoretical model itself needs to be revised. From the "cost-benefit" analysis, North puts forward the theory of system change only when the expected net benefit of innovation is greater than the expected cost of a new institutional arrangement.

The development and changes of institutions are not mechanical changes, but gradual changes similar to biological evolution. Evolutionary economics further criticizes and develops institutional economics. Representatives of this school include Bolding, Hodgson, Nelson, Winter, Samuels and others.

Of course, there is also a school of comparative institutions represented by Masahiko Aoki. The theoretical explanation of the differences in systems between countries is still very convincing. However, the mainstream of contemporary institutional analysis is still new institutional economics. Other institutional schools provide good supplements to economic explanations.

2.2. The Development of Game Theory

Game theory is an analysis toolkit designed to help us understand the observed phenomena when decision-making agents interact. The basic assumption underlying this theory is that the decision-making body most seeks to determine the external goal (they are rational) and considers their own knowledge or the expectations of the behavior of other decision-making bodies (their reasoning is strategic).

The economics edifice constructed by Adam Smith in The Wealth of Nations, the market is perfectly competitive, prices are regarded as exogenously given, and the interaction between actors is ignored. Obviously, this is not in line with the reality. Nash's equilibrium solution of non-cooperative game analysis between actors first proposed by Nash broke the deadlock and brought changes to microeconomic analysis. In the articles of Borel (1921) and Von Neumann (1928), the concept of abstract strategic game was first proposed. Nash (1950a) formed the concept of Nash equilibrium in the context of this type of game; the basic ideas contained

therein can be traced back at least to Cournot (1838). The Nash equilibrium solution is regarded as the core of game analysis.

Non-cooperative games are mainly divided into static and dynamic games according to whether time is introduced (the order of decision-making by actors); according to whether the information is complete: complete information and incomplete information. The pairwise combination of these two divisions results in four types of non-cooperative games: static games with complete information, static games with incomplete information, dynamic games with complete information, and dynamic games with incomplete information. Static game analysis is also called standard game (strategic game); dynamic game analysis is also called extended game. The above four game equilibrium solutions are: Nash equilibrium, Bayesian Nash equilibrium, subgame refined Nash equilibrium, and refined Bayesian Nash equilibrium. Table 1 below summarizes the four games mentioned above and the corresponding four equilibrium concepts and their development, and also roughly reflects the status of Nobel Prize winners in non-cooperative games.

Table 1. The classification of the game and the corresponding equilibrium concept (own processing according to Zhang (2004))

action equence / **information**	**static**	**dynamic**
complete	static game with complete information; Nash equilibrium; **Representative:** Nash (1950, 1951)	complete information dynamic game; subgame refined Nash equilibrium; **Representative:** Zelten (1965)
incomplete	static game with incomplete information; Bayesian Nash equilibrium; **Representative:** Haysani (1967-1968)	dynamic game with incomplete information; refined Bayesian Nash equilibrium; **Representative:** Zelten (1975), Kreps and Wilson (1982), Fudenberg and Taylor (1991)

2.3. The Application of Game Theory to the Connection Point of Institutional Economics

In the system comparison, according to whether the participants make decisions at the same time or in order, should static game analysis or dynamic game be adopted respectively? A strategic game is a model of a situation in which each participant chooses and only chooses an action plan once, and the decisions of all participants are made at the same time (that is, each participant does not know when choosing an action plan Action plans of other participants). In contrast, the extended game model emphasizes the possible sequence of time: each participant can not only consider his own action plan at the beginning of the game, but also consider his action plan whenever he has to make a decision.

For example: How does the introduction of "transaction costs" change the profit function of participants? For the analysis of institutional economics, the theoretical methods of competitive equilibrium are basically no longer applicable. In order to further clarify the essence of game theory, game theory is compared with the theory of competitive equilibrium. Game theory considers that the decision-making body attempts to obtain information about the behavior of other participants before making a decision, while the assumption given by competition theory is that each participant is only interested in certain environmental

parameters (such as prices), even if these parameters are Determined by the actions of all participants. We illustrate the difference between the two theories by considering the following situation: In this situation, the level of a certain behavior (such as fishing) of each participant depends on the degree of pollution, which in turn depends on all participants. activity. If we use competition theory to analyze, we will look for a pollution level consistent with the actions of all participants. At this time, every participant believes that this degree is a given; if we use game theory to analyze, we require that each participant's actions are optimal, and at this time, each participant and other participants are expected to cause pollution is given.

For the evolutionary economics of the institutional economics school, you can just use a variant of game theory: evolutionary game theory to model and analyze. Game theory has formed an analysis model to find out three or five elements for institutional economics analysis: participant, action set, return function, (state space, corresponding probability).

2.4. Summary of Specific Application Examples

Institutional economic analysis is mainly used in institutional reform and institutional design. For example, the setting of standards: the selection of military logistics service providers from the theory and development of supplier relations, the selection of logistics service provider index systems, and the combination of other methods (Jiang & Wang, 2020). The game between e-commerce vendors, and their mutual competition is not only electricity prices, but also power supply services and power quality; the game between electricity sellers and generators is divided into two situations: cooperation and non-cooperation between electricity sellers and electricity users. Dynamic game (Chen & Zhang, 2019). The demand side under the smart grid and the open power market has given users more choices, and game theory as an important tool for multi-agent decision-making optimization problems is expected to solve many problems in this field (Liu & Gao, 2018). Use game theory and other tools, to study the elimination decision-making behavior of training units under different elimination compensation mechanisms (Song, 2016).

In terms of environmental policy and system formulation: a dynamic game model of bounded rationality between the government and enterprises has been constructed to simulate the impact of three types of policy reforms, including environmental taxation, environmental protection vertical reform, strengthening public supervision, and environmental protection incentives, on the green development behavior of enterprises after the 18th National Congress of the Communist Party of China. Effect (Gu & Li, 2020). Based on game theory, the initial water rights allocation and the current status of water market research, the current status of water resources allocation research, and the current status of water conflict management research are reviewed, and the current problems of water resources research based on game theory are analyzed (Lu & Zhagn, 2020).

Evolutionary Economic Analysis: Research Progress of Social Dilemma Game Model, Evolutionary Game Theory and Equilibrium Analysis Method; Research Progress of Social Dilemma Game and Cooperative Evolution under Reward and Punishment Mechanism and Reputation Mechanism; Research on Social Dilemma Game and Cooperative Evolution with

Separation Strategy and Exploitation Strategy Progress; Research Progress in Social Dilemma Game and Cooperative Evolution under Network Reciprocity (Quan & Zhou, 2020). A review of the dynamics of evolutionary games based on random processes and their cooperation mechanisms in limited populations (Wang & Gu, 2019).

3. Game Analysis

In order to simplify the analysis, we assume that only two villages (A, D) are seeking licenses, and the total number of licenses issued by the government remains the same, that is, the sum of the licenses of Village A and Village D remains the same. We can carry out modeling analysis according to the four types of non-cooperative game classification. This article only conducts a detailed game analysis under the condition of complete information. For incomplete information, considering it is more complicated, we will briefly describe it, and we can continue to analyze and expand it later.

3.1. Under the Condition of Complete Information (That Is, the Government Is Open and Transparent, And the Actions of the Village Are Visible). Static Analysis

1. Villages A and D are exactly the same. In order to obtain a license, both must spend the same cost. Moreover, both villages are faced with the fact that the license sales volume does not meet the market demand and the farmers' planting supply exceeds the original license supply. Because of the complete information, the government has a certain understanding of these two villages, but it is not clear about their respective demand differences. Therefore, only one village is going to obtain a license, and it will definitely be issued. In this way, the competition between villages faces a prisoner's dilemma. The income matrix of villages A and D is shown in Table 2.

Table 2. Income matrix of A and D villages

D / A	don't strive for	strive for
don't strive for	6，6	0，8
strive for	8，0	2，2

Note: The Model of Prisoner's Dilemma

The government's revenue is the sum of the revenues of the two villages. In fact, the government most hopes that the two villages will not compete and issue licenses according to the village conditions observed by the government. The government's total revenue is 12. The equilibrium point of the prisoner's dilemma is that both villages compete for licenses. If both villages compete for licenses, they will lose costs for rent-seeking. In the end, the government's revenue will be only 4.

2. Village A is larger than Village D. The government issues licenses in this way: As long as one village obtains a license, it will issue a corresponding proportion of licenses to the two villages according to the size of the village. In this way, the competition between villages is similar to the game of wise pigs. The income matrix of villages A and D is shown in Table 3.

Table 3. Income matrix of A and D villages

D / A	don't strive for	strive for
don't strive for	4，0	3，3
strive for	7，-1	0，0

Note: The Game of Wise Pigs

The government's total revenue is up to 6, which means that only one village can get a license. At the same time, according to the line drawing method, the Nash equilibrium solution is obtained for the village A to obtain the license, and the village D does not fight for the license, and finally the optimization can be achieved.

3.2. Under the Condition of Complete Information (That Is, the Government Is Open and Transparent, and the Actions of the Village Are Visible). Dynamic Analysis

Dynamic analysis, in order to simplify and clarify the analysis ideas, we assume that one factor that causes dynamic changes is the difference in the proportion of adolescents in the population. Assuming that investment in young people is the most efficient, this group of people is the most innovative, and the initial investment will bring high returns in order to realize the fundamental rejuvenation of the village. And suppose that both villages A and D are farsighted (both will actively invest in young people to increase the amount of human capital of this group of people).

1. Except for the high proportion of young people in Village A, Villages A and D are exactly the same. At this time, compared with the previous static analysis, the prisoner's dilemma still exists, and A will definitely fight for it, because the second stage will widen the gap and cause A's economic scale to be larger than D's economic scale, so using the previous static analysis in the second case, it is always a game of wise pigs in the end. If the government does not regulate, the economic scale gap between A and D will diverge.

2. In addition to the high proportion of young people in Village A, Village A is larger than Village D. It has always been a wise pig game. If the government does not regulate, the economic scale gap between A and D will diverge.

3. In addition to the high proportion of young people in Village A, Village A is smaller than Village D. The income of the two villages is the same in the Nash equilibrium in the wise pig game in the previous article. In the early stage, A's strategy was not to fight for a license plate and to free ride. However, due to the high proportion of young people in Village A and great development potential, the economic scale will eventually exceed D. In this way, the latter will reverse to the second situation above. In the later stage, A will actively strive for licenses. In general, the economic scale between A and D will first converge and then diverge.

3.3. Under the Condition of Incomplete Information (The Behavior of the Government and the Village Is Not Transparent)

Combined with the model used by game theory in information economics, there are problems of moral hazard and adverse selection. Therefore, a reasonable mechanism design

must be carried out to select the true category. The two constraints that the mechanism design must meet: participation constraints and incentive compatibility.

4. Conclusions and Recommendations

4.1. Conclusions

In the third part of the game analysis under the condition of complete information, in the static analysis, if two villages are exactly the same, they will fall into a prisoner's dilemma. In the end, the Nash equilibrium is to obtain a license plate, resulting in a loss of efficiency; when the two villages are not the same, will fall into the income matrix similar to the wise pig game. In the end, the Nash Equilibrium is that the village with a large economic scale will fight for the license, and the other village will not fight for the license. The final result is Pareto effective.

By introducing the proportion of young people in each village to conduct a dynamic analysis, it is found that there are three types: except for the different proportions of young people, the two villages are exactly the same. In the first stage, the two villages are in a prisoner's dilemma. Due to the investment in young people, the economic growth of villages with a high proportion of young people will be faster. The second stage is similar to the game of wise pigs. Finally, the economic scale of villages with a high proportion of young people is getting larger and larger than that of another village, and the game behind has always been wise pigs. The village with a high proportion of young people always fights for the license plate, and another village does not fight for the license; the village with a high proportion of youth has a large economy, so the dynamic game has always been similar to the game of wise pigs, and the proportion of young people is high. Villages with a high proportion of youths have small economic scales, so the first situation (a prisoner's dilemma) may appear in the dynamic game process, and the main process is still similar. In the game of wise pigs, a village with a high proportion of young people will not fight for a license if its economic scale is smaller than that of another village, but another village will fight for it. Until the economic scale of a village with a high proportion of youths has been growing more than that of another village, it will actively fight for the license, while the other village will not fight for it.

4.2. Suggestions

Through the above analysis, we can see that under the condition of complete information and static analysis, the government should design a mechanism to prevent the two villages from falling into the prisoner's dilemma and cause efficiency losses; when the economic scales of the two villages are different, the Nash equilibrium solution is Par The government should not intervene if it is an effective solution. In the dynamic analysis, we can see that the final result is that the village with a high proportion of young people will eventually have a larger economic scale, and the economic scale with another village is getting bigger and bigger. The government should pay attention to the education and human capital investment of young people. This is the fundamental way to realize rural revitalization.

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