

# The analysis of game relationship between government and enterprise in industrial poverty alleviation

Yongfei Li, Guoshun Ma

**Abstract**— Industrial poverty alleviation is to increase the income of farmers through industrial development. At present, enterprises actively participate in industrial poverty alleviation under the mode of "enterprise + farmer" and have achieved good results. However, due to the different understandings of local governments on poverty alleviation policies and the information asymmetry between the government and enterprises, the poverty alleviation construction failed to achieve the expected goals. Based on the model of industrial poverty alleviation, this paper uses evolutionary game theory to analyze the dynamic evolution process of local government and poverty alleviation enterprises' strategy selection by establishing replicated dynamic equation, and obtains the evolutionary stable strategy of both sides of the game. The conclusion shows that the choice of local government poverty alleviation methods, the degree of punishment for negative poverty alleviation and the reduction of industrial cost has a direct impact on the development of industrial poverty alleviation, and put forward several suggestions on the sustainable effect of industrial poverty alleviation.

**Index Terms**— industrial poverty alleviation; sustainability; evolutionary game; evolutionary stability strategy

## I. INTRODUCTION

Poverty alleviation and development is not only related to the blessings of tens of millions of people in China, but also related to the realization of the goal of building a moderately prosperous society in all respects. After years of hard work, China's poverty alleviation work has achieved a series of research results, formed a set of theory combined with China's national conditions, and poverty alleviation achievements have attracted worldwide attention, rural poverty has been greatly alleviated, the number of rural people living under the poverty line has been greatly reduced, and the income of rural residents has increased steadily, upgrading has laid a solid foundation for achieving a moderately prosperous society in all respects. With the introduction of the precise poverty alleviation mechanism, industrial poverty alleviation has become an important part of poverty alleviation in China. Therefore, to enable farmers in poverty-stricken areas to embark on the virtuous cycle [1] of self-development as soon as possible, the study of the game relationship among the government, enterprises and farmers in the industrial poverty alleviation is an important link in promoting the industrial poverty alleviation. In order to better

realize the national industrial poverty alleviation strategy and fully stimulate the enthusiasm of enterprises and farmers, it is very necessary to study the game relationship among the participants in industrial poverty alleviation. Industrial poverty alleviation refers to the process of poverty alleviation and development, which is market-oriented, economic efficiency-centered and industrial development-based [2]. From the perspective of economics, the production of a regional products depends not only on the possession of natural resources, but also on the organizational level of production factors related to product production, and the organizational level of production factors determines the degree of industrial development. That is, the industry determines products, the level and quality of industrial development determines the level of competitiveness of a region, and determines the level of poverty and prosperity of a region. Therefore, industrial poverty alleviation is to expand and strengthen the characteristic industries in poor areas, extend the industrial chain [3, 4], change the resource advantages into economic advantages, and fundamentally improve the competitiveness of a region. Industrial poverty alleviation has always been one of the main modes of poverty alleviation in China. It plays an important role in poverty alleviation and development work. While achieving significant results, there are also many problems. Therefore, the research on industrial poverty alleviation has important theoretical and practical significance.

At present, many scholars have discussed the above game problems. Arthur Okun and Paul Samuelson put forward the famous anti-poverty theory [5], which laid the foundation for the study of poverty alleviation. American economist Nurkse thinks that the root cause of poverty is mainly the lack of capital. Mark Lips and other researchers have studied the problem of poverty in China and pointed out that the key to improving the performance of poverty alleviation in China lies not in the increase of capital input, but in improving the efficiency of the use of poverty alleviation funds. At the same time, Peter Roche [6] analyzed the effect of poverty alleviation projects in China, and concluded that the selection of indicators, poor counties and matching methods would affect the estimation of poverty alleviation effect. The uncertainty of project effect made it difficult for participants to obtain permanent income, which provided a useful reference for current poverty alleviation research. Chinese scholar Li Xia [7] studied the precise poverty alleviation model of industries led by leading enterprises. In order to ensure that cooperative leading enterprises adopt positive poverty alleviation strategies, the government should adjust its role orientation, assume service functions, promote the precise poverty alleviation

Guoshun Ma, College of Mathematics and Statistics, Northwest Normal University, Lanzhou, China

Yongfei Li, College of Mathematics and Statistics, Northwest Normal University, Lanzhou, China

marketization of industries and improve the interest linkage mechanism of leading enterprises to drive the industry's precise poverty alleviation model. Zhang Li [8] studied the development of poverty alleviation cooperation in eastern and western regions of China, discussed the current situation, problems, policy effects and internal mechanism of poverty alleviation cooperation, and put forward policy recommendations to promote the development of poverty alleviation cooperation in eastern and western regions. Yan Dongdong [9] emphasized the importance of government departments in supervising enterprises. Zhang Peiyuan [10] believe that industrial poverty alleviation is an endogenous development mechanism, while the government plays a supporting and supervisory role, it should also encourage enterprises to actively participate in poverty alleviation.

The above literature focuses on the supervision of industrial poverty alleviation and the allocation of funds [11,12], the role of local government in industrial poverty alleviation and the game between government and poverty alleviation enterprises [13,14]. However, with the increasing efforts of poverty alleviation in China, there are some unreasonable assumptions in the literature. Therefore, this paper is based on the above-mentioned research, on the basis of evolutionary game theory [15,16], the game model of local government and poverty alleviation enterprises is established, and the Evolutionary Stability Strategy (ESS) of both sides of the game and the main factors affecting the choice of strategy are analyzed, which provides a theoretical reference for improving the industrial poverty alleviation mechanism and promoting the sustainable development of industrial poverty alleviation. At the same time, it also hoped to play a scientific guiding role for the government in formulating poverty alleviation policies.

## II. MODEL

### 2.1 The basic assumptions of the model

According to the actual situation of industrial poverty alleviation, the strategy choice of local government and poverty alleviation enterprises has a direct impact on the ultimate benefit of farmers in industrial poverty alleviation, thus determining the implementation effect of industrial poverty alleviation policy. We assume that there are two types of participants in the model, one is the local government, and the alternative strategy is policy support and fund support for poverty alleviation, which are two different forms of government poverty alleviation. Policy support mainly refers to the assistance of enterprise location selection, the promotion of product brands and the combination of sales channels (including online sales) and so on. Fund support is

that the relevant institutions directly distribute funds to farmers in a reasonable proportion; the other is poverty alleviation enterprises, which can choose proactive poverty alleviation and negative poverty alleviation strategies. The negative poverty alleviation refers to enterprises using deceptive means to seek maximum benefits. In the game, both sides are bounded rational decision makers, and both are under the condition of complete information, through continuous imitation and learning to improve their strategies.

Policy support is a strategy adopted by the government to attract enterprises to participate in industrial poverty alleviation. We assume that its cost is  $C_1$ , and fund support is a strategy adopted by the government for the direct benefit of farmers. We assume that its cost is  $C_2$ . Of course, from a social perspective, policy support is more conducive to the sustainability of industrial poverty alleviation. The effect is more in line with the goal of national industrial poverty alleviation.

The cost of enterprises actively participating in industrial poverty alleviation construction is  $C_p$ , and the expected return is  $R$ . At the same time, if the government chooses policy support, then the enterprise will get help from the government in various aspects of operation, so as to obtain additional income  $E$ . Let  $f$  be the punishment for the enterprise's negative poverty alleviation after being discovered by the government, such as direct fines, cancellation of participation and corresponding disclosure and the like,  $\lambda$  is the probability that the enterprise's negative poverty alleviation behavior is discovered by the government ( $0 < \lambda < 1$ ), including the report rate generated by the farmers' dissatisfaction with the behavior.

The positive social benefits of the government's industrial poverty alleviation construction are  $S$ , at the same time, if the enterprise chooses proactive poverty alleviation strategy, then the good social impact that the government department gets is  $k$ , let  $b$  is the adverse social impact of the enterprise's choice of negative poverty alleviation strategy. For the quantitative relationship of the parameters, we will give them in the analysis below.

### 2.2 Establishment of model

Assuming that the local governments with  $x$  ratio choose the policy support strategy, the proportion of the fund support strategy is  $1 - x$ ; the proportion of the enterprises with  $y$  ratio choose the proactive poverty alleviation strategy, and the proportion of the negative poverty alleviation strategy is  $1 - y$ . We get the return matrix of the game between the two sides, as shown in Table 1.

Table 1 game return matrix

Enterprise	Local government	
	Policy support	Fund support
Proactive poverty alleviation	$R + E - C_p, S + k - C_1$	$R - C_p, S + k - C_2$
Negative poverty alleviation	$R + E - \lambda f, S - b - C_1 + \lambda f$	$R, S - b - C_2$

The expected profits of policy support and fund support for local government and the average profit of population are  $U_{g1}, U_{g2}$  and  $\bar{U}_g$  respectively:

$$U_{g1} = y(S + k - C_1) + (1 - y)(S - b - C_1 + \lambda f) = S - b - C_1 + \lambda f + y(k + b - \lambda f)$$

$$U_{g2} = y(S + k - C_2) + (1 - y)(S - b - C_2) = S - b - C_2 + y(k + b)$$

$$\bar{U}_g = xU_{g1} + (1 - x)U_{g2}$$

The replicated dynamic equation for local governments to choose policy support is

$$F(x) = \frac{dx}{dt} = x(U_{e1} - \bar{U}_e) = x(1-x)[C_2 - C_1 + (1-y)\lambda f] \quad (1)$$

Let  $F(x) = 0$ , we get  $x = 0, x = 1, y^* = 1 - \frac{C_1 - C_2}{\lambda f}$ ;

The expected profits of proactive poverty alleviation and negative poverty alleviation for enterprises and the average profit of population are  $U_{e1}, U_{e2}$  and  $\bar{U}_e$  respectively:

$$\begin{aligned} U_{e1} &= x(R + E - C_p) + (1-x)(R - C_p) = R - C_p + xE \\ U_{e2} &= x[R + E - \lambda f] + (1-x)R = R - \lambda f + xE \\ \bar{U}_e &= yU_{e1} + (1-y)U_{e2} \end{aligned}$$

The replicated dynamic equation for enterprises to choose proactive poverty alleviation is

$$G(y) = \frac{dy}{dt} = y(U_{e1} - \bar{U}_e) = y(1-y)(-C_p + x\lambda f) \quad (2)$$

Let  $G(y) = 0$ , we get  $y = 0, y = 1, x^* = \frac{C_p}{\lambda f}$ . The dynamic system (1) - (2) exists 5 equilibrium points  $(0,0), (0,1), (1,0), (1,1)$  and  $(x^* = \frac{C_p}{\lambda f}, y^* = 1 - \frac{C_1 - C_2}{\lambda f})$ .

Below we analyze the stability of equilibrium points in different situations.

### 2.3 The analysis of model

Let  $\alpha = (R + E - \lambda f) - (R + E - C_p) = C_p - \lambda f$ , we call  $\alpha$  as the difference of corporate income. If  $\alpha > 0$ , that is, under the goal of maximizing profit, the enterprise will choose negative poverty alleviation, at this time, the poverty alleviation effect is very small. In this case, the government will choose the fund support strategy to directly benefit the farmers, but it will not achieve the national sustainable poverty alleviation goal; if  $\alpha < 0$ , that is, the enterprise actively chooses to proactive poverty alleviation. In this case, the government will tend to choose policy support, at this time, industrial poverty alleviation will achieve the desired effect, and the positive impact of society will be the best. Similarly, let  $\beta = (S + k - C_1) - (S + k - C_2) = C_2 - C_1$ , and call  $\beta$  as the local government income difference. If  $\beta > 0$ , it means that under the same actual situation, the government will actively choose policy support, which is in line with the country's poverty alleviation goal; if  $\beta < 0$ , the government will tend to choose fund support, and at this time it will not reach the country's ultimate goal of sustainable poverty alleviation.

According to the hypothesis, we have  $0 < y^* < 1$ .

If  $\beta < 0$ , then  $C_1 > C_2$ , when  $y = y^*, F'(x) \equiv 0$ , then all  $0 \leq x \leq 1$  points are ESS.

When  $y > y^*$ , we have  $F'(0) < 0, F'(1) > 0$ , at this time,  $x = 0$  is an evolutionary steady state, that is, in this case, the fund support is the optimal strategy for local governments; when  $y < y^*$ , we have  $F'(1) < 0, F'(0) > 0$ , then,  $x = 1$  is the evolutionary steady state, that is, in this case, the policy support is the optimal strategy for governments. The dynamic phase diagram of these two cases are shown in Figure 1.

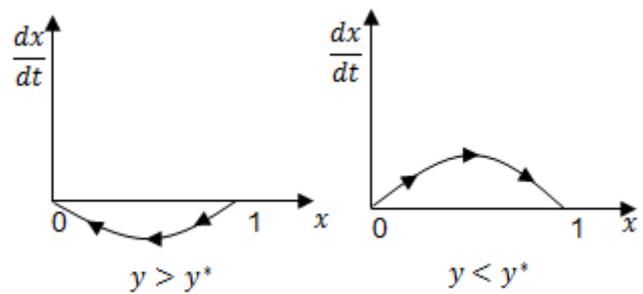


Figure 1 Dynamic phase diagram of  $\beta < 0$

If  $\beta > 0$ , then  $C_2 > C_1$ , at this time,  $C_2 - C_1 + (1-y)\lambda f$  is always greater than zero, since  $F'(x) = (1-2x)[C_2 - C_1 + (1-y)\lambda f]$ , so when  $y = y^*$ , there is  $F'(x) \equiv 0$ , then all  $0 \leq x \leq 1$  points are ESS.

When  $y > y^*$  or  $y < y^*$ , both  $F'(1) < 0, F'(0) > 0$ , at this time,  $x = 1$  is the evolution steady state, that is, in this case, policy support is the optimal strategy for local governments. The dynamic phase diagram of these two cases are shown in Figure 2.

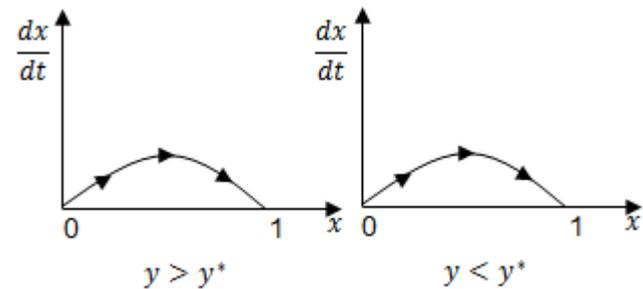


Figure 2 Dynamic phase diagram of  $\beta > 0$

According to the hypothesis, we have  $0 < x^* < 1$ , so  $\lambda f > C_p$ , at this time  $\alpha < 0$ . Here we do not consider the case of  $\alpha > 0$  for the time being, because if all enterprises choose negative poverty alleviation for the purpose of maximizing their own interests, then there will be no significance in discussing poverty alleviation construction under this premise.

When  $x = x^*$ , there is  $G'(y) \equiv 0$ , then all  $0 \leq y \leq 1$  points are ESS.

When  $x > x^*$ , there is  $G'(1) < 0, G'(0) > 0$ , at this time,  $y = 1$  is the evolutionary stable state, that is, in this case, proactive poverty alleviation is the enterprise's optimal strategy; when  $x < x^*$ , there is  $G'(0) < 0, G'(1) > 0$ . At this time,  $y = 0$  is the evolution steady state, that is, in this case, negative poverty alleviation is the enterprise's optimal strategy. The dynamic phase diagram of these two cases are shown in Figure 3.

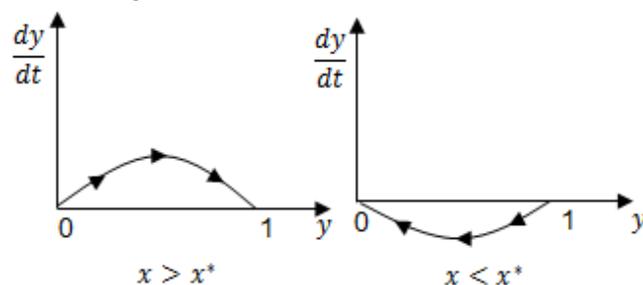


Figure 3 Dynamic phase diagram of  $\alpha < 0$

2.4 The analysis of stability

Based on the above analysis results, the evolution phase diagram of  $\beta < 0, \alpha < 0$  (state I) is made, as shown in Figure 4.

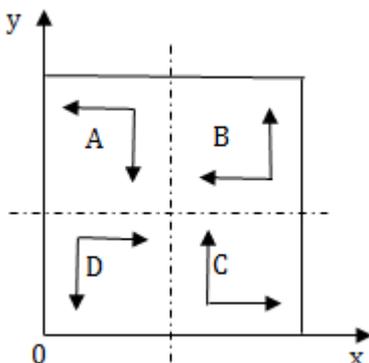


Figure 4 Evolution phase diagram of state I

Phase diagram analysis shows that when  $\beta < 0$ , the local government believes that the benefits of policy support are less than the fund support, that is, the local government decides to mainly support the farmers by using fund in poverty alleviation, so that the farmers benefit directly. At this time, the enterprises have no enthusiasm to participate in poverty alleviation, and the national industrial poverty alleviation goal can hardly be achieved, therefore, state I is the transition period of the game between two sides, and the four strategies in the A~D region are not evolutionary stable strategies of the game. In this stage, although the two sides of the game have interdependent strategic choices, for the beneficiaries of industrial poverty alleviation, farmers only get temporary fund support, but not sustainable poverty alleviation assistance, just as the proverb "Giving people fishing is better than giving people fish" said, at this time the adverse social impact still exists, the effect of poverty alleviation is very small. Therefore, the local government should establish the ideological and theoretical system of sustainable poverty alleviation, and combine the characteristics of industrial poverty alleviation, create a new model of sustainable industrial poverty alleviation, so that farmers can benefit from poverty alleviation policies to the greatest extent.

The evolution phase diagram of  $\beta > 0, \alpha < 0$  (state II) is made, as shown in Figure 5.

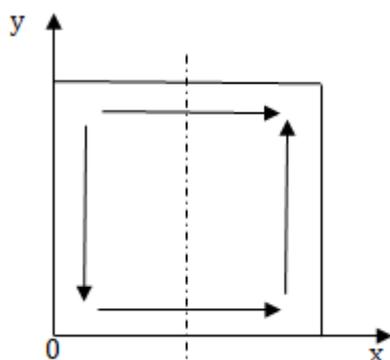


Figure 5 Evolution phase diagram of state II

The phase diagram shows that the point (1,1) is a stable point. When  $\beta > 0$ , the local government realizes the

importance of policy support to the industrial poverty alleviation construction, and then decides to adopt the policy to support the enterprise, so that the farmers can benefit from the industrial poverty alleviation policy continuously. At this time, the enterprises are attracted by the preferential policies of the local government and choose the proactive poverty alleviation strategy, at this point, the system converges to the point (1,1), the optimal evolutionary stability strategy combination of both sides of the game is combined (policy support, proactive poverty alleviation), which is the most ideal state of the game, but also the government is willing to see the results, at this time poverty alleviation construction will achieve the desired results.

III. CONCLUSIONS AND RECOMMENDATIONS

Based on the actual situation, this paper establishes an asymmetric game model between local governments and poverty alleviation enterprises, and analyzes the situation under different strategy choices of the two sides of the game by using evolutionary game theory, and obtains the optimal strategy combination for sustainable and stable development of industrial poverty alleviation. Through the analysis, we find that the strategic choice between the local governments and enterprises is interdependent in the industrial poverty alleviation, and each decision maker's evolutionary stability strategy has many influencing factors. The results of the analysis in this paper have certain guiding significance for the industrial poverty alleviation construction.

Combined with the results of the analysis, the following recommendations are made:

Firstly, the local government cannot directly grant farmers funds to poverty alleviation as the main form of poverty alleviation, otherwise, it will not attract enterprises to participate in poverty alleviation construction or enterprises to adopt negative poverty alleviation strategies, so that it can not play its due role in poverty alleviation policies, of course, the government can according to the specific situation of poverty alleviation farmers, appropriate to give funds to support them.

Second, increase the punishment for negative poverty alleviation for enterprises. the local government should gradually improve the scope of the use of poverty alleviation funds and policies, formulate relevant laws and regulations, and severely punish the illegal and irregular acts of poverty alleviation enterprises, so as to ensure the implementation of the policy support strategy; in addition, to achieve better poverty alleviation effective enterprises should be rewarded accordingly, such as determining the reward quota according to the income growth rate of farmers, so as to encourage enterprises to actively participate in poverty alleviation.

Thirdly, reduce the cost of proactive poverty alleviation through various means, such as using the media to publicize the brand of enterprises, joining and increasing the sales channels of products, and giving corresponding tax incentives to poverty alleviation enterprises. At the same time, the government should take measures to raise the social common awareness of enterprises and farmers, because proactive poverty alleviation strategies can not only increase the income of enterprises, and can benefit farmers and the whole society, so as to achieve a win-win situation of enterprises + farmers, and achieve the goal of national sustainable poverty alleviation.

ACKNOWLEDGEMENT

This research was financially supported by the National Natural Science Foundation of China (Grant NO. 71761031).

REFERENCES

- [1]Chen Jianxun, Thoughts from Nax's "The Poverty Cycle of Poverty" [J], *Shanghai Economic Research*, vol.02, pp.56-59, 1988.
- [2]Wang Huan, Wang Qing, Chen Dequan, Problems and countermeasures of poverty alleviation in industrial projects in accuratepoverty alleviation process [J], *Frontiers of Social Science*, vol.6(1), pp.83-91, 2017.
- [3]Chen Guopeng, The main game and implementation suggestion of advertising poverty alleviation project——based on the “farmer + dealer” supply chain model [J], *Learning and Practice*, vol.08, pp.34-41, 2017.
- [4]Liu Ersi, Innovation industry poverty alleviation mechanism: industrial chain construction and economic development in poverty-stricken areas, *Beijing: China Financial and Economic Publishing House*, vol.09, 2007.
- [5]Theodore W, Schultz, *The Economics Of Being Poor*, 1993.
- [6]Peter Roche et al, Evaluation: Methods and Techniques [M], *Chongqing: Chongqing University Press*, 2012.
- [7]Li Xia, Research on “premium enterprises drive” industry precision poverty alleviation model [D], *Northwest University*, 2017.
- [8]Zhang Li, Research on the development of poverty alleviation cooperation in the eastern and western regions of China [D], *Tianjin University*, 2016.
- [9]Yan Dongdong, Fu Hua, Evolutionary game analysis of leading enterprises participating in industrial poverty alleviation[J], *Rural Economy*, vol.02, pp.82-85, 2015.
- [10] Zhang Peiyuan, Lin Yuancong, Analysis of the game relationship between government, enterprises and poor households in industrial poverty alleviation [J], *Chinese and foreign entrepreneurs*, vol.06, pp. 4-6, 2017.
- [11] Tang Huarong, Evolutionary game analysis of the use efficiency of poverty alleviation funds from the perspective of subject behavior [J], *Study Theory*, vol.15, pp.131-134, 2011.
- [12] Wang Zhizhang, He Cuicui, Industry poverty alleviation and development in continuous destitute areas: Based on the status analysis of the Wuling mountains region [J], *Studies in Sociology of Science*, 2013.
- [13] Wu Xiongzhou, Evolutionary game analysis of competition and cooperative behavior of poor households in poverty alleviation[J], *Journal of Jishou University(Social Science Edition)*, vol.38(06), pp.103-112, 2017.
- [14] Njoya E T, Seetaram N, Tourism contribution to poverty alleviation in Kenya: A dynamic computable general equilibrium analysis[J], *Journal of Travel Research*, vol.57(4), pp.513-524, 2018.
- [15] Hans Peters, *Game Theory* [M], *Springer Berlin Heidelberg*, 2008.
- [16] Weibull J W, *Evolutionary game theory*, *Cambridge: MIT Press*, 1998