Analysis on the Evolution of the Village’s Off-farm Employment Considering the Resources Endowment

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Abstract: With the development of industrialization and urbanization, the proportion of rural off-farm employment gets fast growth. By contrast, there are few researches on village’s off-farm employment which consider the factor of resources endowment. Using the evolution game method and considering the resources endowment, this study focuses on the evolution process and the equilibrium state of village’s off-farm employment. The results show that the proportion of village’s off-farm employment is directly proportional to off-farm income, on the contrary which is inversely proportional to farm income.

Key words: Evolution game, rural off-farm employment, resources endowment

INTRODUCTION

Since the reform and opening-up, China’s rural off-farm employment labor force has been greatly improved. For example, the proportion of off-farm employment was 32.56% in 2010, which raised the off-farm income greatly correspondingly, the off-farm income per capita reached 3032.84 yuan, accounting for 51.24% of the farmers’ net income per capita. While the proportion of off-farm employment is dramatically different among various areas, the proportion of off-farm employment in the areas with rich natural endowment of resources is far lower than the proportion in the sterile areas. For example, the proportion of off-farm employment in Heilongjiang is 21.64%, by contrast, the proportion in Beijing is 81.32%. To be further into each village, the proportion of off-farm employment is much different. In fact the majority of the labor force in some villages is part of off-farm employment, while some villages have very few off-farm employment labor forces and the other villages are between the above ones, while in theory there are rare intensive researches on the way that the results reach these situations.

By using Evolutionary Game Theory, this study analyzes off-farm employment situation in three kinds of villages and the evolutionary process and the reasons which bring to the results. The results shows that the proportion of off-farm employment in inverse appropriate to per capita farm income, which means that the farmers with lower off-farm income incline to engage in off-farm sectors.

MATERIALS AND METHODS

Literature review: Many scholars research on the object of off-farm employment from the angle of the macro and micro and their studies focus on the influencing factors which affect the choice for the rural off-farm employment. From the macro aspect, using time series data and panel data some papers analyze how macro variables influence the rural off-farm employment such as the positive or the negative or non and to what degree the coefficient is, direction (Feng et al., 2010; You and Wu, 2010); From the micro aspect, using econometric model such as Logit model, Probit model and Heckman Selection model, many scholars analyses the influence of micro personal factors, including education, training, health, age, work experience, gender, marriage and et al (Howard and Swidinsky, 2000; Zhang et al., 2008; Huang and Yu, 2012) and family factors, including output of family, human capital, social capital and wealth (Kimhi, 2004; Escobal, 2001; Han, 2012) on off-farm employment and offer the corresponding policy suggestions according to specific factors.

There are a small amount of researches from the perspective of village, Yao (2001) focuses on four villages’ foreign demography and analyzes the above factors’ influence on the salary. Cheng and Shi (2011) also take consideration of the individual inconsistency in family or village, in order to solve this problem the paper establishes the Probit model using clustering robust regression method. However, these studies still can’t explain forming reasons of the current off-farm employment status.

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Regarding to the game theory method, Wei and Yang (2005) use it to analyze the condition and influencing factors of rural labor transfer. Among all, by using generalized replicator dynamic model, Liu et al. (2004), Yang (2006) and Li (2006) establish replicator dynamic prediction model of the rural labor transfer among three different sectors, while the model hypothesis and conclusion can’t accord with the fact. Taking the model hypothesis as the example, the model assumes that the revenue the rural labor force get from the agriculture sector and the urban informal sector is the same, on the contrary the latter one is much higher than the former is high. And the model takes the transfer of a large number of rural labor force as the urban unemployment, which means the benefit is naught, by contrast the migrant workers are engaged in the kinds of work that the city residents don’t want to, which absolutely does not cause unemployment. The conclusion that the employment proportion in agriculture sector is very low, while the rate in the urban formal sector is up to 50%, is obviously not consistent with the reality. Actually, only very low proportion could get work in urban formal sector, while the most labor work in the informal sectors.

Due to the scarcity of the existing researches, from the perspective of the village, this study gives an evolutionary game model. The paper focuses on impact of the village endowment resources on the rural off-farm employment labor force and deduces rural off-farm employment labor force evolution process of different village endowment resources excepting getting the balanced rural off-farm employment proportion. The result conforms to the nowadays off-farm employment situation, which enriches the existing researches.

**Dynamic game analysis of the rural labor off-farm employment**

**Dynamic model of evolutionary game:** Evolutionary game combines game theory and dynamic evolution process. Under the slow learning speed, the game party converts to dominant strategy in a gradual process and we can use evolution dynamic equation to show the adjustment speed of the strategy of the game player, namely replication dynamic formulation (Weibull, 1995).

The rural labor force converting to off-farm sectors is a progressive evolution process, which originally begins with several ones with risk preference engage in off-farm employment. On the one hand, when these people get high income in off-farm sectors than the agricultural sector, the demonstration effect makes others incline to turn to the off-farm sectors, on the other hand, when the off-farm employment is frustrated for the decreasing labor unemployment because of the macro-economic or government positive policy on promoting agriculture output, more labor will come back to the village, so after several years of evolution process the village can get a stable off-farm employment proportion. Evolutionary game theory method can simulate the whole evolution process of the rural labor force off-farm employment, so it is a feasible method for the research.

<table>
<thead>
<tr>
<th>Table 1: Rural labor simplified pay-off matrix</th>
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<tbody>
<tr>
<td><strong>A</strong></td>
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<tr>
<td>G</td>
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<tr>
<td>R(1-x)</td>
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<tr>
<td>d</td>
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A: Agricultural employment, NE: Off-farm employment

**Evolution model analysis of the rural labor off-farm employment:** Using evolutionary game theory to study the rural labor force off-farm employment evolution process, the rural labor force off-farm employment includes two kinds of strategies including the employment in agricultural sector and off-farm sectors, recording as the strategy set S₁ and strategies set S₂, among which the agricultural sector consist of agriculture, forestry, animal husbandry and fishery, the off-farm sectors is the remaining part. In addition to, the off-farm employment consists of rural local employment and migrant workers employment. The farm income consists of the income getting from the agriculture, forestry, animal husbandry and fishery, while the off-farm income consist of the income obtaining from salary and family off-farm business. Therefore, Table 1 shows the rural labor pay-off matrix.

**Model hypothesis:**

- The study only considers village endowment resources, without considering the impact of human capital, social capital and game structure on the game participants’ behavior.
- The rural labor who have been working in off-farm sectors have demonstration effect and the labor chooses the off-farm sectors or not by comparing the off-farm income. When the off-farm income is higher than the farm income, the rural labors imitate and choose the off-farm employment and viceversa.
- Taking R, x as the total number of labor force and the proportion of the total population engaging in off-farm sectors in a village respectively. Taking d as the off-farm income per individual farmer, in order to simplify the model, we assume that the off-farm income is fixed. Taking G as the income from the village farm and G is constant. And the individual farm income is inversely proportional to the total number of the agricultural labor.

Based on the above assumptions, Table 1 shows the rural labor pay-off matrix considering village endowment resources.
Final steady state analysis of the rural labor off-farm employment: Assuming the rural labor revenue getting from the agricultural employment and off-farm employment is $\pi_i$ and $\pi_2$, respectively, the expected revenue of two strategies and the average revenue are the presented below:

$$\pi_i = (1-x) \cdot \frac{G}{R \cdot (1-x)} + x \cdot \frac{G}{R \cdot (1-x)} = \frac{G}{R \cdot (1-x)}$$

$$\pi_2 = (1-x) \cdot d + x \cdot d = d$$

$$-\pi - (1-x) \cdot \pi_1 + x \cdot \pi_2 - (1-x) \frac{G}{R \cdot (1-x)} + x \cdot d$$

According the revenue, we get the replicator dynamic equation:

$$F(x) = \frac{dx}{dt} = (1-x)(\pi_2 - x) = \frac{(1-x)[(1-x)dR - G]}{R}$$

If $F(x) = 0$, we can get all the solutions of the replicator dynamic equation. There’re no more than 2 stable state, namely $x_1 = 1$:

$$x_2 = 1 - \frac{G}{dR}$$

respectively.

According to the properties of evolutionary stable strategy, the stable state that has robustness to tiny disturbance can be called evolutionary stable strategy. In mathematics, which requires $F(x^*)$, the derivative of stable strategy $F(x)$, must be less than zero. Therefore, the derivative of stable strategy $F(x)$ is:

$$F'(x) = \frac{2(x-1) \cdot dR + G}{R}$$

According to Fig. 1, the point:

$$x^* = 1 - \frac{G}{dR}$$

is the evolutionary stable strategy and the derivative of stable strategy at this point is less than zero. In fact, it means that the farmers’ interests situation is stable being decided by the above environmental conditions. Once a few rural labor force choice to shift, the number of transfer labor won’t stop until get to the stable off-farm proportion.

If off-farm proportion is so big that the stable state that the proportion is 100%, a few agriculture proportion variations will diffuse in the village until the off-farm proportion return to equilibrium ratio. The off-farm employment proportion is inversely proportional to overall cultivated land income and the off-farm income is proportional to the total population.

If:

$$1 - \frac{G}{dR} \rightarrow 0$$

$$\frac{G}{dR} \rightarrow 1$$

namely when the farmers’ cultivated land income approaches product of the off-farm income and total population, the off-farm employment proportion approaches zero.

If:

$$1 - \frac{G}{dR} \rightarrow 1$$

$$\frac{G}{dR} \rightarrow 0$$

namely when the farmers’ cultivated land income far less than product of the off-farm income and total population, the off-farm employment proportion approaches 1.

So, if:
1978, with the influence of the national policy guidance and loose household registration system, China choice the Chinese characteristic socialism market economy. On the one hand, with the help of advanced science and technology, the cultivation of crops is much higher than before, which makes a great many rural surplus labor, on the other hand, the high speed industrial construction in large and medium-sized cities has a urgent labor demand, which pulls a large number of rural labor transfer to the city.

Our country is so vast that different regions have different land resources, so the migration process is different among various areas. In the northeast, the land area is huge and fertile, the transfer rural labor is less compared with the whole country. In the eastern coastal cities, such as the Pearl River Delta and Yangtze River Delta Region, the urbanization and market system is better than the middle and west, which makes them being the leader of China's market economy. In the eastern regions, farming income is far less than the income of the off-farm income. No matter in township enterprises or big cities, the ones who first choose off-farm jobs get better, which has also significantly demonstration effect, namely the fellow villagers will follow, finally there are great number of people choose off-farm jobs.

• The research is under the hypothesis of the constant village cultivated land income, total labor and off-farm wage, considering that agricultural production technology and raising the level of mechanization. Considering the continuous improvement of technology and mechanization, the enlarging population and rising off-farm wage, the in-depth analysis and research of off-farm proportion of equilibrium should be further studied.

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