Evolutionary Game Research on the problem of Rural College Graduates returning home for Development in China

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Abstract: Under the background of Rural Revitalization Strategy in the new era, in order to add new impetus, bring new opportunities and create new situation for the increasingly hollow countryside, the country actively calls on rural university graduates to return home to start a business and obtain employment. Despite the active implementation of national policies, the enthusiasm of college graduates to return home is not as strong as expected, so promoting the activity of rural college graduates and encouraging local governments to build a good environment for entrepreneurship and employment are the problems we are facing. Based on the evolutionary game theory, this paper establishes the evolutionary game model of decision-making behavior between local government and rural college graduates, and analyzes evolution processes and results of the whole game system in the different restriction on parameters. The most ideal strategic state is that local governments forwardly support graduates and college graduates actively return to their hometown for entrepreneurship and employment, which can meet the needs of economic development and benefit both sides, according to the evolution of this state, some reasonable suggestions are put forward from different levels.

Keywords: College graduates returning home; Evolutionary game; Duplicate dynamic equation; Evolutionary stability strategy.

INTRODUCTION

Since the reform and opening up, with the continuous progress of urbanization in China, more and more rural surplus labor force has been transferred to the city, resulting in the hollowing out of the countryside, so there are various obstacles in the governance and development of the countryside. In the context of Rural Revitalization Strategy, it is necessary to import more human resources for rural areas and improve agricultural competitiveness. As the power of new generations, college graduates have higher education backgrounds, qualities and abilities, but they have to face great pressure of urban social employment. Under such an opportunity, the state actively encourages rural college graduates to return to their hometown to do a business and obtain employment, aims to inject fresh blood into the development of the cause of "agriculture, rural areas and farmers", stimulate the vitality of local agriculture, guide the development of rural industries, and promote the modernization of agriculture. However, due to the lack of support from local governments, the shortage of rural infrastructure construction, the weak adaptability of university graduates, and the low enthusiasm of returning home, there are still some problems in the continuous realization of this process.

At present, many scholars have studied the problem of college graduates returning home. Tang Nan made a survey of the rural college graduates' willingness to return to their hometown in 10 universities. By using the multivariate statistical model analysis, she put forward reasonable suggestions to promote the return of college graduates. Wang Xiaolong made a research on the guiding mechanism of college students serving the countryside in the new era. He believed that the active cultivation of college students and the continuous integration of college and social forces are conducive to promoting the process that college students return to their hometown and create employment. Gao Dawei applied SWOT to analyze the advantages and problems of college students' returning home for entrepreneurship and employment, and pointed out the necessity of improving social mechanism, broadening financing channels and
strengthening ability cultivation. Yang Xiuli built the “ITC + R” ecosystem for college students to return home and start their own businesses, which solved the problem of matching college graduates with rural posts and provided better employment environment for college students; Pei Lingling analyzed the necessity of entrepreneurship education for returned students, and believed that the active cultivation of colleges and universities can provide the basis of knowledge and ability for returned students to create jobs; Wang Zongyan conducted a survey in a typical area of college students returning home, and explored the role and effect of local government's innovative behavior in college students returning home. Based on the theory of social interaction, Yan Guangfen and other scholars analyzed the driving force that college students choose to return home for development, and proposed that the cultivation of college students' own ability and the establishment of a platform by the government would help to promote this process.

Attracting rural college graduates to return actively home for employment and promoting local economic development mainly depend on the interactive coordination between local government and college students. It can be seen from the above literature that most of them are concerned about the impact of changes in external factors for college students’ return and employment, and there are few in-depth studies on the choice of decision-making behavior between local governments and university graduates. From the perspective of evolutionary game, under the assumption of information asymmetry, this paper analyzes the evolutionary process of decision-making behavior between local governments and college graduates, which truly shows the diversity and complexity of their game behaviors, and puts forward suggestions for guiding college graduates to return to hometown for employment.

MODEL CONSTRUCTION AND ANALYSIS

Model construction:
The two groups of the game are local government and college graduates. According to the actual situation, under the condition of both sides' limited rationality, the local government's strategy is to support (create a good environment for entrepreneurship and employment), not to support; the college graduates' strategy is to return home, not to return home. The specific parameters are assumed as follows:

$F$ refers to the income obtained by the local government in organizing the normal agricultural production activities when the university graduates do not return home.

$T_1$ refers to the gain brought to the local economy when the university graduates return home for employment with the support of the local government.

$T_2$ refers to the gain brought to the local economy when the university graduates return home for employment without the support of the local government. Obviously, with the support of the government, it is more conducive to mobilize the enthusiasm of college graduates for entrepreneurship and employment, stimulate their creativity, and strive to devote themselves to the cause, so as to bring more gains to the local government.

$C_1$ refers to the cost of creating a good employment environment (providing employment opportunities, policy advocacy, innovation projects, etc.) when the local government actively supports.

$C_2$ refers to the cost of human time for college graduates to return home for entrepreneurship and employment.

$C_3$ refers to the cost of human time for college graduates not to return home for entrepreneurship and employment.

$t$ refers to the extra cost (information resource acquisition, knowledge and skills learning, etc.) for college graduates to return home for entrepreneurship and employment without the active support of local government.

$E_0$ refers to the benefit of college graduates returning home for entrepreneurship and employment with the support of the local government.

$E_1$ refers to the benefit of college graduates’ income from employment in other places without returning home.

$E_2$ refers to college graduates’ income from employment in other places without returning home.

$P$ refers to the financial support provided by the central government to the local governments that actively create employment environment for university graduates.

$K$ refers to subsidies provided by the central government for college graduates who are actively engaged in rural undertakings.
Among the group of university graduates, $x$ percent of them choose the return strategy, others choose not to return strategy. Among the group of local government group, $y$ percent of them choose the support strategy, others choose not to support strategy. Based on the above assumptions, the game income matrix of both parties is obtained as follows:

| Local governments | College graduates | Not return home |
|-------------------|-------------------|-----------------|
| Support           | $F + P + T_1 - C_1, E_0 - C_2 + K$ | $F + P - C_1, E_2 - C_3$ |
| Not support       | $F + T_2, E_1 - C_2 - t + K$ | $F, E_2 - C_3$ |

**Model analysis:**

$U_1$ is the expected revenue of college graduates when choosing "returning home" strategy. $U_2$ is the expected revenue of college graduates when choosing "returning home" strategy. $\bar{U}$ is the average expected revenue of college graduates.

$$U_1 = y(E_0 - C_2 + K) + (1 - y)(E_1 - C_2 - t + K) = y(E_0 - E_1 + t) + E_1 - C_2 - t + K$$

$$U_2 = x(E_2 - C_3) + (1 - y)(E_2 - C_3) = E_2 - C_3$$

$$\bar{U} = xu + (1 - x)U_2 = xu(E_0 - E_1 + t) + x(E_1 - C_2 - t + K) + (1 - x)(E_2 - C_3)$$

$$U_1 - \bar{U} = (1 - x)[y(E_0 - E_1 + t) + E_1 - C_2 - t + K - E_2 + C_3]$$

$V_1$ is the expected revenue of local governments when choosing "support" strategy. $V_2$ is the expected revenue of local governments when choosing "not support" strategy. $\bar{V}$ is the average expected revenue of local governments.

$$V_1 = x(F + P + T_1 - C_1) + (1 - x)(F + P - C_1) = xT_1 + F + P - C_1$$

$$V_2 = x(F + T_2) + (1 - x)F = xT_2 + F$$

$$\bar{V} = yV_1 + (1 - y)V_2 = xyT_1 + x(F + P - C_1) + (1 - y)xT_2 + (1 - y)F$$

$$V_1 - \bar{V} = (1 - y)[x(T_1 - T_2) + P - C_1]$$

From the above calculation and analysis, we can establish the replication dynamic equation as follows:

$$\frac{\dot{x}}{x} = U_1 - \bar{U}$$

$$\frac{\dot{y}}{y} = V_1 - \bar{V}$$

$$f(x) = x = x(1 - x)[y(E_0 - E_1 + t) + E_1 - C_2 - t + K - E_2 + C_3]$$

$$g(y) = y = y(1 - y)[x(T_1 - T_2) + P - C_1]$$

The Jacobian matrix $J$ of the system:

$$J = \begin{bmatrix}
(1 - 2x)[y(E_0 - E_1 + t) + E_1 - C_2 - t + K - E_2 + C_3] & x(1 - x)(E_0 - E_1 + t) \\
(1 - x)(E_0 - E_1 + t) & (1 - 2y)[x(T_1 - T_2) + P - C_1] \\
y(1 - y)(T_1 - T_2) & (1 - 2y)(x(T_1 - T_2) + P - C_1)
\end{bmatrix}$$
The trace of Jacobian matrix $J$:

$$TrJ = (1 - 2x)[y(E_0 - E_1 + t) + E_1 - C_2 - t + K - E_2 + C_3] + (1 - 2y)[x(T_1 - T_2) + P - C_4]$$

**Analysis of equilibrium and stability strategy:**

Let $f(x) = 0, g(y) = 0$. By solving the duplicate dynamic equations, we can get the equilibrium points of the above game system under different constraints. According to Jacobian matrix stability theorem, we analyze the evolution path and equilibrium stability strategy of the whole system in each case. There are nine cases in total, as shown in the following table.

| Table 2. stability analysis of equilibrium point under different constraints |
|---------------------------------------------------------------|
| **Case 1** | **Phase diagram** |
| Condition | $E_2 - C_1 - E_1 + C_2 + t - K < 0, C_1 - P < 0$ |
| Equilibrium points | $x = 0, y = 0$ | $x = 0, y = 1$ | $x = 1, y = 0$ | $x = 1, y = 1$ |
| $Det J$ | - | + | + | + |
| $Tr J$ | - | + | N | - |
| Result | instability | instability | instability | ESS |

| **Case 2** | **Phase diagram** |
| Condition | $E_2 - C_1 - E_1 + C_2 + t - K < 0, C_1 - P < 0, T_1 - T_2$ |
| Equilibrium points | $x = 0, y = 0$ | $x = 0, y = 1$ | $x = 1, y = 0$ | $x = 1, y = 1$ |
| $Det J$ | - | - | + | - |
| $Tr J$ | - | + | N | - |
| Result | instability | instability | instability | ESS |

| **Case 3** | **Phase diagram** |
| Condition | $0 < E_2 - C_1 - E_1 + C_2 + t - K < E_2 - E_1 + t, C_1 - P < 0$ |
| Equilibrium points | $x = 0, y = 0$ | $x = 0, y = 1$ | $x = 1, y = 0$ | $x = 1, y = 1$ |
| $Det J$ | - | - | + | - |
| $Tr J$ | - | + | N | - |
| Result | instability | instability | instability | ESS |

| **Case 4** | **Phase diagram** |
| Condition | $E_2 - C_1 - E_1 + C_2 + t - K < 0, C_1 - P < 0$ |
| Equilibrium points | $x = 0, y = 0$ | $x = 0, y = 1$ | $x = 1, y = 0$ | $x = 1, y = 1$ |
| $Det J$ | - | - | + | - |
| $Tr J$ | - | + | N | - |
| Result | instability | instability | instability | ESS |

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| condition | \( E_2-C_3-E_1+C_2+t-K>E_0-E_1+t, C_1>P>T_1-T_2 \) |
|-----------|----------------------------------------------------------------------------------|
| equilibrium points | Det \( J \) | Tr \( J \) | Result |
| (0, 0) | + | - | ESS |
| (0, 1) | - | N | instability |
| (1, 0) | - | N | instability |
| (1, 1) | + | + | instability |

**Case 5**

| condition | \( 0<E_2-C_3-E_1+C_2+t-K<E_0-E_1+t, C_1>P>T_1-T_2 \) |
|-----------|----------------------------------------------------------------------------------|
| equilibrium points | Det \( J \) | Tr \( J \) | Result |
| (0, 0) | + | - | ESS |
| (0, 1) | + | + | instability |
| (1, 0) | - | N | instability |
| (1, 1) | - | N | instability |

**Case 6**

| condition | \( E_2-C_3-E_1+C_2+t-K>E_0-E_1+t, 0<C_1>P<T_1-T_2 \) |
|-----------|----------------------------------------------------------------------------------|
| equilibrium points | Det \( J \) | Tr \( J \) | Result |
| (0, 0) | + | - | ESS |
| (0, 1) | - | N | instability |
| (1, 0) | + | + | instability |
| (1, 1) | - | N | instability |

**Case 7**

| condition | \( E_2-C_3-E_1+C_2+t-K<0, C_1>P>T_1-T_2 \) |
|-----------|----------------------------------------------------------------------------------|
| equilibrium points | Det \( J \) | Tr \( J \) | Result |
| (0, 0) | - | N | instability |
| (0, 1) | + | + | instability |
| (1, 0) | + | - | ESS |
| (1, 1) | - | N | instability |
In the first three cases, the system has four equilibrium points, (1,1) is the evolutionary stable point among them, it can be seen from the given phase diagram that the system will converge to (1,1) no matter what any initial state, that is, university graduates choose the strategy of returning to their hometown for entrepreneurship and employment, and local governments choose the strategy of supporting. At these cases, the evolution result of the system is optimal and in a benign state. Both local governments and university graduates respond positively to the central government’s encouraging policies and measures, which brings a new situation to the rural development and promotes the further realization of the Rural Revitalization Strategy. The emergence of this kind of benign state depends on the financial support guaranteed by the central government, the less cost of local government's active support, and considerable benefits brought by college graduates returning home.

\[ x^* = \frac{C_1 - P}{T_1 - T_2} \quad , \quad y^* = \frac{E_2 + C_2 - C_3 - K - E_1 + t}{E_0 - E_1 + t} \]

In the fourth, fifth and sixth cases, it can be seen from the given phase diagram that the system will converge to (0,0) no matter what any initial state, that is, university graduates choose the strategy of not returning to their hometown for entrepreneurship and employment, and local governments choose the strategy of not supporting. At these cases, the evolution result of the system is in a state of invalid policy. Under the background of the strategy of rural revitalization, the central government strongly called on the rural college graduates to return to their hometown for entrepreneurship and employment, and encouraged the local government to create conditions to absorb talent resources, but neither of them actively conducted this strategy and chose their own development. For the central government, the implemented policies have not achieved results, which is not conducive to the development of rural undertakings in the new era. The main reasons for this ineffectiveness are as follows: on the one hand, the financial support provided by
the central government is limited, which can not attract college graduates to go back to their hometown actively for entrepreneurship and employment. On the other hand, the cost of local government to create a good environment for college students returning their hometown is high, so that they are not willing to invest in it. In addition, a broader development platform for college graduates in economically developed cities is also one of the factors that they choose not to return hometown for entrepreneurship and employment.

In the seventh case, it can be seen from the given phase diagram that the system will converge to (1,0), that is, university graduates choose the strategy of returning to their hometown for entrepreneurship and employment, but local governments choose the strategy of not supporting. This is a suboptimal solution of the whole evolutionary system. In this situation, although the local government don’t give certain support, university graduates still return home to start their own business and employment, to a certain extent, which promotes the development of rural undertakings. But lack of local government coordination makes the rich resources in rural areas not be fully developed and utilized, and college students need to face many difficulties under the existing rural conditions, they are not motivated to devote themselves to the rural cause.

In the eighth case, it can be seen from the given phase diagram that the system will converge to (0,1), that is, university graduates choose the strategy of not returning to their hometown for entrepreneurship and employment, but local governments choose the strategy of supporting. In this evolution process, although the central government provides financial support to the local government which creates a good employment environment, the graduates don’t actively return to their hometown to start their own businesses, which undoubtedly results in a waste of resources. The state invest in the policy, but will suffer losses.

In the ninth case, the system has five equilibrium points, (1,1) is the evolutionary stable point among them, S(x*,y*) is the saddle point, it can be seen from the given phase diagram that the system will converge to (0, 0) when the initial state is in the lower left area B, that is, college graduates choose not to return to their hometown for entrepreneurship and employment, and local governments choose not to support the strategy; correspondingly, the system will collect (1, 1) when the initial state is in the upper right area A, that is, college graduates choose the strategy of returning to their hometown for entrepreneurship and employment, and local governments choose the strategy of support, which is a kind of benign game state we hope to achieve. So we know that the evolution process of the whole system depends on the initial state of the system and the position of the saddle point. In order to achieve the desired state, we can expand the area A in the upper right through the change of parameters, so that the system can evolve to benign state as much as possible. The changes of specific parameter to expand area A are as follows:

| parameter | alteration | Moving direction of saddle point | Area A |
|-----------|------------|----------------------------------|--------|
| K         | increase   | left                             | expand |
| P         | increase   | down                             |        |
| T₁        | increase   | left                             |        |
| t         | decrease   | left                             |        |
| C₁        | decrease   | down                             |        |
| C₂        | decrease   | left                             |        |

**CONCLUSIONS AND SUGGESTIONS**

Combined with the actual situation, this paper establishes a reasonable evolutionary game model for the local government group and the college graduates group, and analyzes the evolution process of the decision-making behavior of both sides in different cases. Local governments actively support rural college students returning home and university graduates can also positively return to hometown to devote themselves to rural undertakings is a common vision of our society. We can see that the policy support of the central government, the prepared cost of local governments, the cost and ability of college students returning home are all necessary factors to affect this process. According to the above analysis results, the following suggestions are put forward to promote the process that rural college students
return to their hometown to start own business:

a. The financial support of the central government is guaranteed. When the central government provides enough financial support to local governments, they will release the burden, strive to build a good environment for college graduates, and attract talent resources to return to rural areas for development. More subsidies given by central government to rural college students returning home can mobilize their enthusiasm, they will be more confident to meet new challenges and actively participate in the rural cause.

b. The support behavior of local government is organized. In order to create a good environment for rural college graduates, local governments should cooperate with rural enterprises and other social forces, and establish a sound supporting mechanism for the entrepreneurship and employment of university graduates returning home, which not only has the opportunity to reduce the operational cost paid by the local government, but also can fully meet the needs of college graduates, so that they can actively return to their hometown for entrepreneurship and employment. Meanwhile, local governments also need to solve the difficulties they face in rural undertakings, and provide precise help.

c. The process of training students in colleges is targeted. For the rural graduates who are willing to return home, colleges should offer some courses on rural development, entrepreneurship and employment, so that they can learn and master the relevant knowledge in advance, and improve their practical ability. This will not only be conducive to the return of graduates to less wall, more benefits, but also help local governments to trust the ability of university graduates and actively guide them to a better direction.

d. The career planning for students is valuable. The realization of a life value lies in whether its social value can be fully embodied. College graduates should recognize the important position of developing agriculturein China in the new era, abandon the inherent thinking pattern of rural areas, and align their career planning with the national mission. As a rural college graduate, it's a responsibility and a glory to return home to work and make contributions to rural revitalization.

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