From Mobility to Settlement: Evolution of Inter-generational Migrant Families to Realize Family Migration

Zhanwen Sun, Fang Zheng, Guowei Zhang*

Business School, Shandong University of Political Science and Law, Jinan, China

*Corresponding Author.

Abstract:

In China, since the 18th National Congress, the policies of citizenization system have been basically improved, and the urbanization rate has continued to improve. However, family migration from one generation to another is still incomplete. Based on the theory of new migration economy, the evolution model of inter-generational double population on family migration is constructed, evolutionary analysis on the action of double population to realize transformation from mobility to family migration is made. Studies have shown that it is probable for inter-generational migrant families to realize family migration because of joint employment advantages of two generations of laborers. Therefore, at this stage, it is necessary to make full use of the favorable period of cross-integration of family migration and inter-generational migration in order to promote inter-generational migrant families to migrate the whole family at first and achieve the goal of 100 million rural residents being changed into urban residents. The system simulation further shows that it still takes several years or ten years to achieve family migration. Some methods are meaningful to accelerate the process. And the methods include improving income of inter-generational migrant family moving between urban and rural areas, reducing the cost increment and income spillover of family migration efforts of various groups, strengthening the joint efforts taken by dual-populations to achieve family migration, and accelerating the rate of return of joint efforts. However, if considering the cost of housing purchases, inter-generational migrant families cannot settle in cities. Based on the above, the reasons in terms of the implementation of citizenship system policies such as household registration system, residence permit system and equalization of public services are analyzed, and optimization measures are proposed.

Keywords: *Inter-generational migrant family, Family migration, Evolutionary analysis, System simulation.*

I. INTRODUCTION

Rural-urban migration of agricultural migrant population has been one of the most noticeable phenomena in China since the reform and opening up. The migrant population increased from 2 million[1] in 1983 to 172.66 million in 2018(data from 2018 Migrant Workers Monitoring Survey Report). In recent years, the number of agricultural migrants who have migrated to cities in the form of family migration has been increasing[2]. According to the dynamic population monitoring data of National Population and

Family Planning Commission's, the population of family migration accounted for nearly 25% of agricultural migrant population in 2016, the population of migrants who had other family members living together in the same cities accounted for more than 70% of agricultural migrants, and more and more migrants in agriculture begun to migrate together with family members in the hope of realizing family migration. In the same time, the inter-generational replacement trend of the old generation and the new generation of agricultural migrants is going on. From 2013 to 2018, the agricultural migrants of new generation who were born after 1980 gradually became the main part of agricultural migrants, and their proportion of agricultural migrant population increased from 46.6% to 51.5% within the migrating family, inter-generational changes of members of the first and second generations, which accompany the family migration process, are also ongoing. How to solve the co-evolution of family migration and inter-generational migration of agricultural migrants is one of the important issues in the field of current and future population migration.

Inter-generational migrant families are defined as rural-urban migrant families where both the first- and second-generational laborers are employed in cities, which mean the first- and second-generational laborers drive the migration of some non-labor members in order to realize family migration gradually. In this study, the first- and second-generational laborers of migrating households are not defined according to the first-generational laborers born before 1980 and the second-generational laborers born in 1980 and later, but the family labor force can be clearly distinguished into two different generations through field surveys. And meanwhile non-labor members driven by the first and second generations of laborers to cities are also classified according to whether the main economic source of non-labor members is supplied by the first-generational laborers or the second-generational laborers. With in-depth observation of the inter-generational relationship of migrating family members, the first and second generations of laborers are the major groups who provide economic resources in family migration. This migration sequence can be divided into two processes based on the inter-generational relationship of labor. The first process is migration driven mainly by the first-generational laborers (hereinafter referred to as the first generation), and the second process is migration driven mainly by the second-generational laborers (hereinafter referred to as the second generation). If the inter-generational migrant families where the first and second generations of laborers are both mobile workers are taken as the research object, and then how can the transition from the first generation to the second generation to complete the family migration be realized? What are the costs and benefits of migration and the benefits sharing mechanism between groups? Obviously, the relative stability of the first and second generations of inter-generational migrant families is the result of maximizing their own interests. Failure to complete family relocation to settle in cities may be harmful to the maximization of overall family interests. How to coordinate the relationship between maximizing the interests of the first and second generations and maximizing the overall interests of the family is the core issue in the evolution process of inter-generational migrant families to realize family migration. This study is conducive to studying the dynamic evolution process of migrant families, and then to enrich the existing theory of population migration. The analysis of influencing factors in the process of dynamic migration will help the implementation of the citizenization policy since the 18th National Congress of the Communist Party of China, the reduction of cost of citizenization, and the macro trends of citizenization and new urbanization.

II. LITERATURE REVIEW

The new migration economic theory formed and developed after the 1960s is the main theory to study the phenomenon of family migration. The state of migration and its influencing factors are the focus of the study, which can be divided into three research phases. In the first phase of the 1960s and 1970s, Schwarzweller took the lead in studying the phenomenon of remittances of migrating members, providing migration paths and information to non-migrating members, and held that the hope of reunification would be conducive to family migration[3]. Sandell considered that during the process of husband and wife migration, the wife's entry into the migrating labor market was an important factor in realizing family migration[4]. Mincer paid attention to the impact of family member structure and human capital on the economic benefits of family migration[5]. In the second phase of the 1980s and 1990s, on basis of previous researches, Stark O. changed the research object from individual migration to family migration, of which the goal was to pursue the maximization of family benefits[6]. He studied the family members' investment portfolios and contractual arrangements in the migration process, thereby improving the relative economic status of families in the community[7]. Besides, Cooke and Bailey[8] and other scholars used the new migration economic theory to analyze the influencing factors of family migration. In the third phase for nearly 20 years, scholars such as Tervo[9], Ritsila and Tervo[10], Nivalainen[11], Swain and Garasky[12], Geist and Mc Manus[13] studied the influencing factors of family migration from the aspect of migrants' individual characteristics(that was gender, marriage, Education, etc.), family characteristics, community characteristics, migration areas, and so on. During this period, there were many studies on family migration in China in the perspective of individual and family level by Zhao[14], Jalan and Ravallion[15] and Xu and Xie[16].

In China, research on family migration began with the research of Li Qiang[17], Du Ying and Bai Nansheng[18]. The research focused on two aspects. On the one hand, it analyzed the migration status of migrant families and sorted out the characteristics and patterns of family migration. Zhou Hao[2], Yu Xuejun[19], Sheng Yinan[20] and other scholars analyzed the family status of China's overall agricultural migrant population. During this period, Chen Xianshou [21], Zhai Zhenwu[22], Zhu Mingfen[23], Tang Zhen[24], Xu Qinghong[25], Chen Suqiong[26] and other scholars analyzed the migration families in various places in China. On the other hand, it analyzed the influencing factors of migrating families and mainly analyzed the factors at the individual and family levels. Research on migration sequence related to family migration process, the current research mainly focused on the family migration sequence of couples. Li Qiang[17] and Hong Xiaoliang[27] divided the types of family migration into single children going out, brothers or sisters going out, husband and wife being separated, parents and children being separated, and the whole family going out. Duan Chengrong[28] and Sheng Yinan[20] divided the family migration sequence stages into singles going out, couple migration, nuclear family (including wife, husband and children) migration, and extended family migration. Wu Fan[29] divided the family mobility into three kinds of mobility states: non-family mobility, semi-family mobility and complete family mobility. These studies suggested that because of internal and external factors of the family, different types of families had different advantages and disadvantages in achieving family migration.

In summary, the analysis of intra-generational migration that is driven by couples is currently the most

extensive analysis, and there are fewer analyses of inter-generational changes in family migration. In the migration evolution sequence, the completion of family migration by migrant families is an important sign of family migration, and it can better reflect the macro migration goals and requirements. However, there have been many studies to discuss the migration of some family members, which doesn't have the goal of whole family migration driven by migration evolution. In view of this, this article analyzes internal member structure and migration sequence of inter-generational migrating families, in order to enrich the existing studies. In terms of research methods, it is planned to carry out process evolution analysis based on the "risk sharing, benefit sharing" mechanism between the first and second generations during the migration process, with the purpose of in-depth analysis of the migration evolution process.

III. RESEARCH HYPOTHESES AND THEORETICAL ANALYSIS

3.1 Research Hypotheses

3.1.1 Inter-generational grouping hypothesis of inter-generational migrating family members

The new migration economic theory analyzes the behavior of family migration under the condition that the family's interests are maximized in the unit of the migrating family. But Stark O[6]. pointed out that although the executor of labor migration behavior usually appeared as a single migrant, labor migration itself had more meaning than maximizing the benefit of a single person, that the migration behavior was actually the result of the decision-making of a group of people, or the execution of the decision-making of a group of people, and that the family was one of the forms of existence of this group of people. It can be seen that migrant families make decisions from the perspective of the whole family when making migration decisions. However, in actual implementation, the migration and allocation of labor, which is the main source of the family economy, is carried out in different stages; and the non-labor members of the family follow the migration behavior attached to the labor. In this sense, inter-generational migration of family members is divisible, and laborers can be divided into the first and second generations. And meantime non-labor distribution depends on the migration of the first- and second-generational laborers, so it can be divided into the first and second generations.

3.1.2 Groups' income spillover hypothesis of inter-generational migration families

The portfolio theory of the new migration economic theory believes that the objection of family members' migration is to promote family income and to resist the instability of pure agricultural income. When making the migration decision, inter-generational migrating families first consider maximizing the overall interests of the family, and then consider maximizing the interests of different generations. But when taking specific action, each generation should first maximize its own interests, and then maximize the overall family's interests through the spillover of benefits. Stark O. once used remittances to explain this family contract arrangement of spillovers, and pointed that the remittance itself was a continuous contractual arrangement between the migrant and his family members, and was by no means the result of altruism. Therefore, this kind of contractual arrangement of sharing risks and benefits together enables the first and second generations to obtain benefits through revenue spillover. However, since inter-generational

migrant families have the first and second generations of laborers who go out to work at the same time, which means that the first and second generations both have income, the "free-rider" behavior may promote migration of the whole family for a period of time. But from the perspective of realizing a long-term evolution goal, it may not be able to complete the evolution process of the whole family's migration. Therefore, the research assumes that income spillovers among inter-generational migrating families groups may promote family migration in the short term. But in the long-term if the first and second generations improve their own self-sufficiency capabilities of income and expenditure and reduce spillovers, the goal of achieving family migration will be easily realized.

3.1.3 Stage hypothesis of migration sequence of inter-generational migrating family

Inter-generational migration of family members and migration sequences are conductive to achieving family migration. The migration of all generations is to maximize their own interests, and thereby to promote the maximization of family interests and to prevent the risk of family income stability. Due to internal and external environment restrictions, the cognition and abilities about family migration of the first and second generations are different, and therefore there are two strategies, one of which is to achieve family migration, and the other of which is not to maintain mobility. The first (or second) generation striving to achieve family migration has the ability to fully anticipate the benefits and changes brought by family migration and the requirements of the labor force raised by family migration, and takes action and takes all advantages to achieve family migration. And in contrast, no effort is made to maintain fluidity. Each generation is a limited rational individual that seeks to maximize its own interests. It will comprehensively consider factors such as costs and benefits, and continuously adjust its own strategy based on the other group's strategy, which forms the evolution process of the family migration of the first and second generations.

Based on the survey of inter-generational migrating families and the above hypothesis and theoretical analysis, and also on the existing research results, for the evolution to family migration of the first and second generations, the parameter assumptions are proposed as follow,

Firstly, if the first and second generations do not work hard to maintain liquidity, their returns will be respectively R_1 and R_2, and meantime $R_1 > 0$ and $R_2 > 0$.

Secondly, if only the first generation takes action to improve the overall level of family migration, it is expected that family migration will be achieved. At this time, the benefit of the first generation is $(1 + \alpha_1)R_1 - \Delta C_1$. When the first generation takes action to realize family, the increase rate of income is $\alpha_1(\alpha_1 > 0)$ (it is referred to as return rate of a single group's effort). Marginal cost of a single group's effort for the first generation to achieve family migration is $\Delta C_1(\Delta C_1 > 0)$. At the same time, through the contractual arrangement mechanism of sharing risks and benefits together, the return of the efforts of the first generation has spilled over into the second generation, which is $E_1(E_1 > 0)$.

Thirdly, if only the second generation takes action to realize family migration, the benefit of the second

generation group is $(1 + \alpha_2)R_2 - \Delta C_2$. The return rate of a single group's effort of the second generation is $\alpha_2 (\alpha_2 > 0)$. Marginal cost of a single group's effort for the second generation is $\Delta C_2 (\Delta C_2 > 0)$. Similarly, through the contractual arrangement mechanism of sharing risks and benefits together, the return of the efforts of the second generation has spilled over into the first generation, which is $E_2 (E_2 > 0)$.

Fourthly, if the first and second generations both take action to achieve family migration, it will be more conducive to overall migration. Due to the cooperation mechanism between the first and second generations, with the original efforts of the first and second generations, income spillovers are reduced, and the overall household income level is further improved. At this time, the returns of the first and second generations are respectively $(1 + \beta_1)R_1 - \Delta C_1$ and $(1 + \beta_2)R_2 - \Delta C_2$. When the first and second generations both make efforts to realize family migration, the expected rate of return (it is referred to as the return rate of joint effort) is $\beta_1 (\beta_1 > \alpha_1)$ and $\beta_2 (\beta_2 > \alpha_2)$.

3.2 Theoretical Analysis of Evolution Process

3.2.1 Evolution payment matrix of family migration

Based on the above assumptions, evolution payment matrix of family migration of inter-generational migrating family, as shown in Table I.

TABLE I. Evolution payment matrix of family migration of inter-generational migrating family

The first generation	The second generation	
	Take action (y)	**Don't take action ($1 - y$)**
Take action (x)	$(1 + \beta_1)R_1 - \Delta C_1$, $(1 + \beta_2)R_2 - \Delta C_2$	$(1 + \alpha_1)R_1 - \Delta C_1$, $R_2 + E_1$
Don't take action ($1 - x$)	$R_1 + E_2$, $(1 + \alpha_2)R_2 - \Delta C_2$	R_1, R_2

3.2.2 Replication dynamic equations and evolution analysis

The proportion of the first generation that takes action to achieve family migration is x, and the proportion of the second generation that takes action to achieve family migration is y. The expected benefits of the first generation's efforts to achieve family migration are:

$$u_{11} = y[(1 + \beta_1)R_1 - \Delta C_1] + (1 - y)[(1 + \alpha_1)R_1 - \Delta C_1] \tag{1}$$

The expected benefits of the first generation that don't take action to maintain moving are:

$$u_{21} = y[R_1 + E_2] + (1 - y)R_1 \tag{2}$$

The average expected return of the first generation is:

$$U_1 = xu_{11} + (1-x)u_{21} \tag{3}$$

According to formulas (1), (2), and (3), the replication dynamic equation whether or not the first generation can take action to achieve family migration is obtained, as follows

$$\frac{dx}{dt} = x(1-x)\left[y(\beta_1 R_1 - \alpha_1 R_1 - E_2) + \alpha_1 R_1 - \Delta C_1\right] \tag{4}$$

Similarly, the replication dynamic equation whether or not the second generation can take action to achieve family migration is obtained, as follows

$$\frac{dy}{dt} = y(1-y)\left[x(\beta_2 R_2 - \alpha_2 R_2 - E_1) + \alpha_2 R_2 - \Delta C_2\right] \tag{5}$$

When $\frac{dx}{dt} = 0$ and $\frac{dy}{dt} = 0$, in the two-dimension plot $M = \{(x,y); 0 \le x, y \le 1\}$, there are five partial equilibrium points whether the first and second generations take action to realize family migration or not. The points are O(0,0), A(1,0), B(0,1), C(1,1) and saddle point D(x_D, y_D) (see Figure 1).

$$x_D = \frac{\alpha_2 R_2 - \Delta C_2}{\alpha_2 R_2 + E_1 - \beta_2 R_2}, \quad y_D = \frac{\alpha_1 R_1 - \Delta C_1}{\alpha_1 R_1 + E_2 - \beta_1 R_1} \tag{6}$$

According to the method proposed by Friedman[30], on the basis of the partial stability analysis of the Jacobian matrix, the stable points whether the first and second generations take action to achieve family migration are only O (0,0) and C (1,1). Figure 1 depicts the dynamic evolution whether the first and second generations take action to achieve family migration. The first and second generations eventually evolve towards O (0, 0) or C (1, 1). Being affected by the current migration status, if the first and second generations enter the area I or area IV, the probability that both generations take action to achieve family migration will continue to increase, and eventually family migration will be realized. If the first and second generations enter the area II or area III, the probability that both generations make no effort to maintain the state of moving will continue to increase, and eventually the state of moving will tend to be maintained.
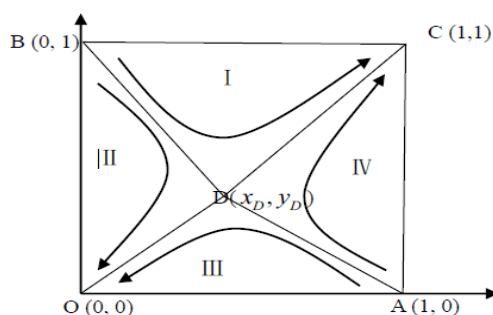

Fig 1: Evolution dynamic phase diagram of family migration

3.2.3 Analysis of the influencing factors of the evolution process

Based on the above analysis, whether the first and second generations migrate to realize family migration is affected by the current status of the first and second generations. The probability that the current state falls into areas I- IV is affected by the size of each area, and the size of the area is affected by the saddle point D (x_D, y_D) and the parameter values of x_D、 y_D . The area of II and III can be obtained from Figure 1 as follows:

$$S_{\text{II,III}} = \frac{1}{2}(x_D + y_D) \tag{7}$$

Combining the formulas (6) and (7), we can get the 10 parameters that affect the size of the area $S_{\text{II,III}}$. Except for α_1 and α_2, the other 8 parameters have a strictly monotonic relationship with $S_{\text{II,III}}$. Table II discusses the relationship between the relevant influencing factors and $S_{\text{II,III}}$, and analyzes the parameters of the evolutionary probability of the first and second generations' efforts to migrate to achieve family migration.

TABLE II. Influencing factors of migrating evolution of the first and second generations

Parameters	Saddle points	Area	Probability of migration	Results and optimization strategies
$\Delta C_1\downarrow, \Delta C_2\downarrow$	$x_D\downarrow, y_D\downarrow$	$S_{\text{II,III}}\downarrow$	increase	The smaller the marginal cost of a single group's efforts of the first and second generations is, the higher the probability of the migration evolution is. The marginal cost of a single group's efforts comes from the increase in living expenses, education expenses, and social security expenses in the process of moving to settlement. Efforts to reduce the marginal cost of a single group's efforts need to increase the supply of basic public services such as housing, education, medical care, and pensions for migrant families. The sharing mechanism of public cost for urbanization and that of the exiting mechanism for protecting rural rights and interest should be implemented.

$R_1 \uparrow, R_2 \uparrow$	$x_D \downarrow, y_D \downarrow$	$S_{\text{II,III}} \downarrow$	increase	The greater the current income of the first and second generations is, the higher the probability of the migration evolution is. The income of the current state of migration of the two generations, which is the income of migrant workers, is related to the accumulation of internal family capital and the supply of external family institutions. It are needed to increase the accumulation of capital of the migrating agricultural population, and to achieve equalization of the household registration system and incidental public services in order to increase the income of migrant workers.
$E_1 \downarrow, E_2 \downarrow$	$x_D \downarrow, y_D \downarrow$	$S_{\text{II,III}} \downarrow$	increase	The larger the spillover benefits of the first and second generations are, the lower the probability of migration evolution is. That is, if the expected income of family migration from a single generation is less than the benefits of the other group spilled over to this group; both the generations will adopt the free-rider behavior. The spillover income of the two generations is mainly used for the basic living expenses of the other group after the migration. Therefore, the self-sufficiency of income and expenditure of each generation needs to be improved, spillovers need to be reduced, and compensatory expenses due to lack of public services need to be reduced.
$\beta_1 \uparrow, \beta_2 \uparrow$	$x_D \downarrow, y_D \downarrow$	$S_{\text{II,III}} \downarrow$	increase	The higher the income of the first and second generations making efforts together is, the higher the probability of the migration evolution is. That is to say, the higher the expected income after family migration is, the more it is probable to realize family migration. In order to increase the expected income of family migration, it is also required to optimize the capital accumulation inside the family and the supply system outside the family. And therefore, the marginal benefits of joint efforts will significantly increase and be greater than the marginal benefits brought by the free-rider.

$\alpha_1 \uparrow, \alpha_2 \uparrow$	uncertain	uncertain	uncertain	If $\Delta C_1 > \alpha_1 R_1$ or $\Delta C_2 > \alpha_2 R_2$, that is the marginal cost of a single group's effort is less than the marginal cost, the family remains mobile. If $\beta_1 R_1 - E_2 < \Delta C_1 < \alpha_1 R_1$ or $\beta_2 R_2 - E_1 < \Delta C_2 < \alpha_2 R_2$, that is, the marginal cost of a single group's effort is lower than the marginal benefit, but higher than the difference between the marginal benefit and the spillover benefit of the joint effort, there will be two strategies of A (1,0) or B (0,1) with the effort of a single group. Under this condition, the probability of migration evolution maybe increase, but maybe also decrease because of the external positive effect of a single group's efforts.

IV. SYSTEM SIMULATIONAND ANALYSIS

Based on the migration evolution theory of the inter-generational migrating family, the change of the parameters can change $S_{\text{II,III}}$ in the phase diagram, which also means it can change the evolution probability of the evolution process to C (1,1). Therefore, through system simulation, the migration evolution process of the first and second generations can be described more realistically; by changing a certain parameter of the replication dynamic equation, the effect on the evolution path of family migration can be further observed. In order to achieve the above, based on the original data of the migrating households surveyed and the initial state of the system evolution, the parameters are changed so that the two generations can enter area I or IV and joint efforts are made to achieve family migration. The goal of the system simulation is to promote the inter-generational migrating families to move to the ideal stable point C (1, 1).

4.1 Simulation Data Description

4.1.1 The source of simulation data

The data of this research came from 8 cities of *Migration Monitoring Questionnaire for Agricultural Migrating Families* held by the National Social Science Project Group in February 2018(the respondents were the inter-generational agricultural migrant families with incomplete migration and family migration, who were from Songjiang District of Shanghai, Jinan and Qingdao of Shandong, Suzhou of Jiangsu, Quanzhou of Fujian, Wuhan of Hubei, Changsha of Hunan, and Xi'an of Shanxi). There were 5189 households in total, which had the first- and second-generational laborers; there were two kinds of families, one of which was migrating separately, and the other of which had realized family migration (see Table III). According to the requirements of system simulation, all surveyed migrant families were classified in terms of three levels. Firstly, according to the number of family population, they were divided into two-members, three-members, four-members and five or more-members families. Secondly, according to the foregoing theoretical analysis, family members were divided into the first generation and the second generation. Thirdly, the migration stage of each household was analyzed to distinguish whether the family was

migrating separately or migrating as a family (was considered as a joint effort of the two generations). And moreover, the first generation or the second generation of migrating families was further analyzed according to his willingness and ability of migration, in order to distinguish whether or not efforts were being made to achieve family migration, and to identify families that maintained mobility and families in which a single generation was working hard to achieve family migration.

TABLE III. Family sample data summary of system simulation

Number of family population	Number of samples				The number of people who made efforts in families in which one singe generation made efforts	
	In total	Families that maintained original state	Families in which one singe generation made efforts	Families in which two generations made efforts	The first generation	The second generation
2	806	143	170	493	1.00	1.00
3	2023	1246	474	303	1.98	1.99
4	1712	514	476	722	2.38	2.18
5 or more	648	206	93	349	2.98	2.63

Note. The two-person families were selected from the families in which the first generation and the second generation were laborers. The three-person families were selected from the families in which the population of the first generation was two and that of the second generation was one, or vice versa, and also there was at least one laborer in each generation in the family. The families with four or more persons were also families with at least one laborer in each generation.

4.1.2 Determination of simulation variable values

According to the life cycle of the first- and second-generational laborers working together of inter-generational migrating families, the evolution cycle is determined 30 years, and the simulation variable values are determined as follows:

Firstly, migrant families are originally mobile families. The number of the people of each generation in such families is determined by the number of the people of the families in which one singe generation makes efforts. Based on the number of the people, the first-generational mobile income R_1 and the second-generational mobile income R_2 can be obtained to maintain the income of the families that maintain state of mobility by means of the number of people and structural adjustment (see Table IV for details).

Secondly, in terms of the difference between the cost-benefit of the efforts made by the first generation to achieve family migration and the cost-benefit of the efforts made by the second generation to maintain mobility, the return rate of the first generation's efforts is α_1, the marginal cost of the first generation's efforts is ΔC_1, and the spillover benefits that promote the second generation to realize family migration are E_1 (see Table IV for details). The statistical data of ΔC_1 is the increase in living expenses that include living expenses, education expenses and social security expenses for the migration from family to

settlement (about 70% of migrant families live in rented houses, so living expenses here mainly refer to rent expenses; for the migrant families that build and buy their own houses, the housing cost will be allocated to the two generations of the family over 30 years, which is considered to be the annual rental expense of each generation). The statistical data of E_1 is increment of the marginal expenditure which the first generation spills over to the second generation for basic living after family migration.

In the same way, the return rate of the second generation's efforts to realize family migration is α_2, the marginal cost of the second generation's efforts is ΔC_2, and the spillover benefits are E_2 (see Table IV for details).

Thirdly, based on the income status of the inter-generational family that has achieved family migration, the number of the people of families in which one singe generation made efforts, and the structure adjustment of the income of each generation, and the comparison with the income of the corresponding generation of the family that maintains mobility, the return rate of the efforts made by two generations is obtained, that is, β_1 and β_2 (see Table IV for details).

TABLE IV. Determination of variables values for family migration of inter-generational families

Total population of the family	R_1 Ten thousand Yuan	R_2 Ten thousand Yuan	ΔC_1 Ten thousand Yuan	ΔC_2 Ten thousand Yuan	E_1 Ten thousand Yuan	E_2 Ten thousand Yuan	α_1 %	α_2 %	β_1 %	β_2 %
2 persons	2.030	2.364	0.870	0.739	0.361	0.375	50.9	44.7	83.4	73.4
3 persons	4.347	4.575	0.774	0.802	0.408	0.488	31.8	30.6	50.4	58.0
4 persons	4.518	4.727	0.752	0.817	0.341	0.368	25.5	28.0	33.2	36.6
5 persons or more	5.576	5.362	0.881	0.837	0.459	0.415	19.7	20.8	36.5	38.1

Note. R_1, R_2 =the income of one generation of families that maintain mobility*the people of one generation of families in which one single generation makes effort/the people of corresponding generation of mobile families

β_1, β_2 =(the income of one generation of families that realize family migration*the people of one generation of families in which one single generation makes effort/the people of corresponding generation of families which achieve family migration/the income of corresponding generation of mobile families-1)*100%.

4.2 System Simulation Analysis

4.2.1 Evolution path of family migration determined by variable's original value

The data of the experimental group is determined. According to the existing literature and survey results, the proportion of the families in which two generations work together to realize family migration is close to 40%, so that the convergence speed of the system evolution is equal to the difference between the

ideal state ($x = y = 1$) and the initial state ($x = y = 0.4$) / time taken, that is, the rate of convergence is $v = \Delta x / \Delta t = \Delta y / \Delta t$. And subsequently data simulation is performed.

From Figure 2, according to the original values of the variables of family migration of the inter-generational migrating families, the first and second generations strive to achieve the family migration, and the time required to converge to the ideal state ($x = y = 1$) are respectively 16 years (for two-person family), 6 years (for three-person family), 13 years (for four-person family) and 9 years (for family of five or more persons). Among them, the time required for three-person family and family of five or more persons to achieve family migration have been shortened, compared with the time (that was 13 to 17 years) for couples with children to achieve family migration, which was estimated in 2014 by the author of this article[31]. The reasons are because for the families having couples with children, two couples are the main laborers, and other members are mainly non-labor, and the proportion of labor force of inter-generational migrating families is generally better than that of families having couples with children (see Table III). The simulation results also show that because the total family population is different and the structure of family labor and non-labor personnel change, the time required to achieve family migration is different. According to the data in Table III, compared with inter-generational migrating families with a total family population of two persons, in the families of three persons, the non-labor burden rate increase from 0% to 1%, and meanwhile the labor force increase from 2 to about 3, and the time to realize family migration have been reduced by 10 years. However, when the total family population is four or five and more, with the comparison with 3-person families, the number of laborers has increased; at the same time, the non-labor burden rate has increased from 1% to 17% and 16%, and the time to achieve family migration has increased by 7 and 3 years respectively. It can be seen that the proportion of labor force of inter-generational migrating families that have the first- and second-generational laborers simultaneously working is better that of nuclear families with husband and wife, and thus it is easier for the inter-generational migrating families to realize family migration. The labor and non-labor structure of the labor force of the migrating family directly determines the time to realize family migration.
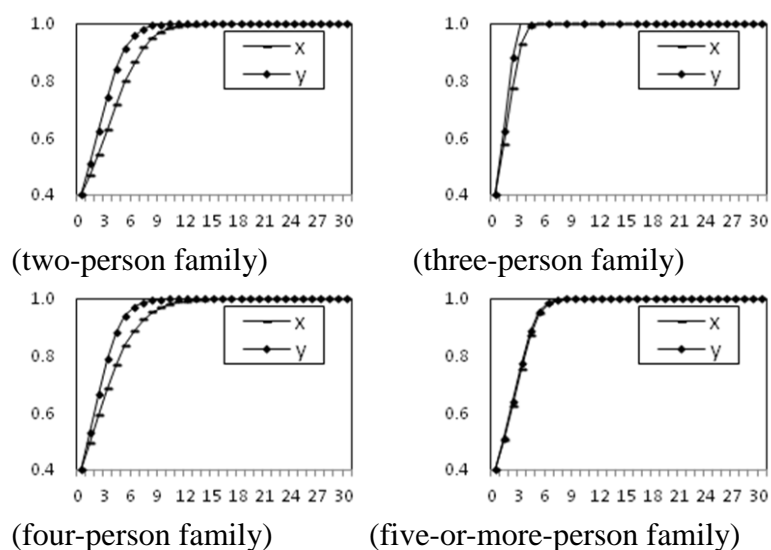

(two-person family) (three-person family)

(four-person family) (five-or-more-person family)

Fig 2: Evolution path of family migration of inter-generational families

4.2.2 Impact of variable value changes on evolution path of family migration

The data of the experimental group is set. According to the annual increase in the income and expenditure per capita of urban and rural residents and that of agricultural migrants released by the National Bureau of Statistics (deducting price factors), which is about 7% in recent years, the annual change of each variable of the evolution analysis is determined as the control value * (1 + 7%). And subsequently data simulation is performed.

(two-person family)   (three-person family)

(four-person family)   (five-or-more-person family)

Fig 3: Impact of the income of mobility on evolution path of family migration

(two-person family)   (three-person family)

(four-person family)   (five-or-more-person family)

Fig 4: Impact of the return rate of joint efforts on evolution path of family migration

The impact of annual changes of R_1, R_2, β_1 and β_2 on the evolution path of family migration is analyzed. Comparing the simulations of the four types of families in Figure 3 and Figure 2, it is found that

when the first and second generations do not strive to maintain mobility, the benefits R_1 and R_2 increase 7% annually, and the time required for the system evolution to converge to the ideal state ($x = y = 1$) is shorten from 16 years to 12 years (for two-person families), from 6 years to 5 years (for three-person families), from 13 years to 10 years (for four-person families), and from 9 years to 7 years (for five-or-more-person families). Comparing the simulations of the four types of families in Figure 4 and Figure 2, the impact of the revenue rate β_1 and β_2 of the efforts made together by the first and second generations on the evolution path of family migration is almost the same as the impact of R_1 and R_2. Further the action elasticity of the variables (ratio of the dependent variable change / ratio of the independent variable change) is examined. The elasticity of R_1, R_2, β_1 and β_2 is greater than 1 (rich elastic). It can be seen that the increase of the income of migration between city and countryside of the first and second generations and that of the expected income of family migration can speed up the evolution process of family migration. That means if the income of the first- and second-generational mobility is significantly higher than that of similar families, this relative advantage is conducive to promoting migrant families to family migration. If the expected revenue of the first and second generations working together to achieve family migration is significantly higher than that of migrant families, this expectation is also beneficial to promoting migrant families to realize family migration. The survey shows that increasing the income of the mobility of migrating families and the expected income of family migration also need to further increase the capital accumulation of the family's labor force and obtain favorable external institutional support. At present, the level of education skills training for migrant families has gradually improved. The proportion of migrating agricultural laborers who have received high school or higher education has exceeded 40%, and that of the second-generational laborers has reached more than 50%. However, there are less than 25% of senior technicians and less than 12% of migrating laborers who participate in formal skills training, which are the internal constraints that limit the growth of the income of migrant families. Migrant families do not have long-term career planning, lack the knowledge about the contradiction between supply and demand of skilled jobs, and lack the knowledge about how to match skills and income, and thus they are unwilling to participate in skills training. On the other hand, they are unable to participate in skills training due to income and labor intensity. The lack of policies, energy, and investment in employment skills training held by enterprises and governments for agricultural migrant population is also an important reason. Since the 18th National Congress of the CPC, the reform of the household registration system and supporting measures has basically been completed. However, the implementation of the household registration system related to family migration and the issue of differential treatment of public services are still important factors affecting the growth of the revenue of migrant families. Except for some mega-cities, household registration has been fully liberalized, but some practical problems are still more prominent. The reform of household registration is different in different cities and regions. The cities that have liberalized household registration still have problems such as population planning and different treatments in social security, education, housing and other public services, which are related to household registration. The implementation of the residence permit policy is uneven, and there are problems related to the implementation of policies and the settlement of migrant families. For example, the implementation of the six basic public services and the convenience of seven services provided by *Interim Regulations on Residence Permits* have not been better realized, and while some cities target high-level talents, the settlement of migrating agricultural families is difficult.
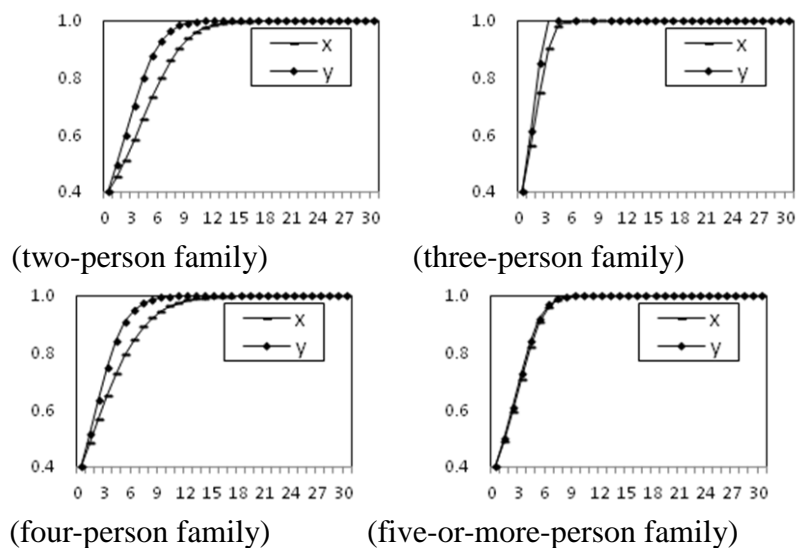
(two-person family)   (three-person family)

(four-person family)   (five-or-more-person family)

Fig 5: Impact of marginal cost of efforts of a single generation on evolution path of family migration

The impact of changes of $\triangle C_1$ and $\triangle C_2$ on the evolution path of family migration is analyzed. Comparing the four types of families in Figure 5 and Figure 2, it is found that when the marginal cost of the effort made by a single generation increases by 7% annually, the time required for system evolution to converge to the ideal state ($x = y = 1$) is increased from 16 to 19 years(for two-person families), from 6 years to 7 years(for three-person families), from 13 years to 16 years (for four-person families), from 9 years to 10 years (for five-or-more-person families), and $\triangle C_1$ and $\triangle C_2$ are both flexible. It can be seen that reduction of the difference between marginal costs of one generation's making efforts and that of one generation's not making efforts to realize family migration can accelerate evolution process of family migration. According to the setting of variables, the factors affecting the marginal cost of one generation's efforts mainly come from housing expenditure, education expenditure, and social security expenditure. The survey shows that, on the one hand, the proportion of migrant families buying and constructing their own houses still does not exceed 20%, and the cost of renting houses and urban housing prices have skyrocketed, and the living expenditure for migrant families to achieve family migration is still great. On the other hand, there are three outstanding issues in basic public services such as housing, education, social security. First, transfer and convergence policies related to pension and medical insurance have made connection of policies between urban-rural regions and that between different regions better, but the implementation of policies varies in different regions, and different migrant families have different perceptions of the connection process. Second, the proportion of migrant families that enjoy security housing such as public rental housing is still less than 3%, and thus the problem of relocating housing is still relatively prominent. Third, the post-enjoyment of compulsory education for children of migrant families still exists in areas where education resources are tight, and meanwhile the burden of non-compulsory education is still relatively heavy.
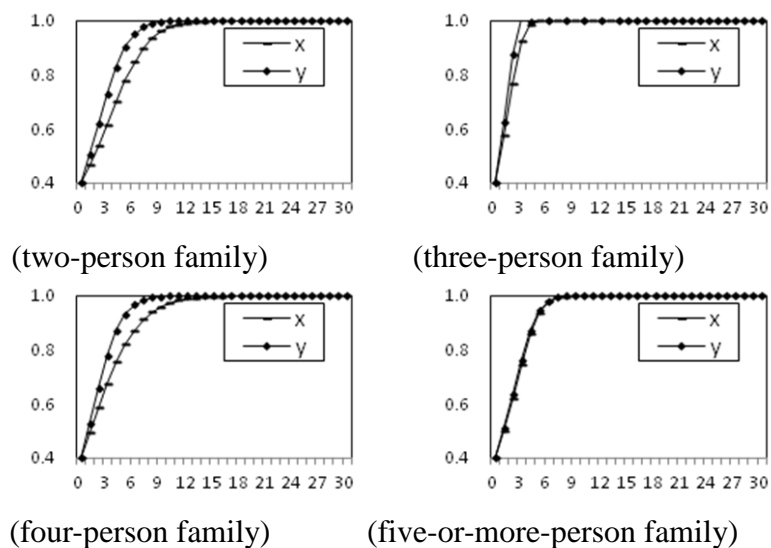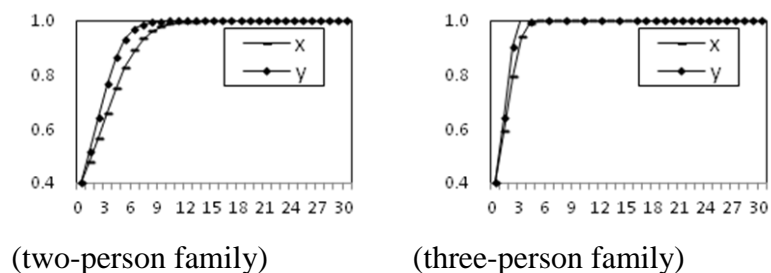
(two-person family)   (three-person family)

(four-person family)   (five-or-more-person family)

Fig 6: Impact of spillover income on the evolution path of family migration

The impact of annual changes of E_1 and E_2 on the evolution path of family migration is analyzed. Comparing the four types of families in Figure 6 and Figure 2, when the spillover income E_1 and E_2 of the first and second generations increases by 7%, the time required for the system evolution to converge to the ideal state ($x = y = 1$) is increased from 16 years to 18 years (for two-person families), from 6 years to 7 years (for three-person families), from 13 years to 15 years (for four-person families), from 9 years to 10 years (for five-or-more-person families), and E_1 and E_2 are both flexible. It can be seen that reducing the spillover income of the first and second generations can accelerate the evolution process of family migration. The spillover income of the first and second generations is mainly used for the basic living expenses of the other generation, so the self-sufficiency of income and expenditure of each generation needs to be improved to reduce spillovers. At the current stage, although the income of agricultural migrant workers has increased synchronously, it is still relatively less than the income of urban workers, and the income gap between the two groups has gradually widened (from 2013 to 2017, the proportion of the income of rural migrants to that of urban employees decreased from 61% to 56%), which is harmful to self-sufficiency of income and expenditure. On the other hand, it is also related to the equalization of urban public services. Migrant families must make up for the lack of public services such as social security contributions, education and medical expenses through family expenditures.
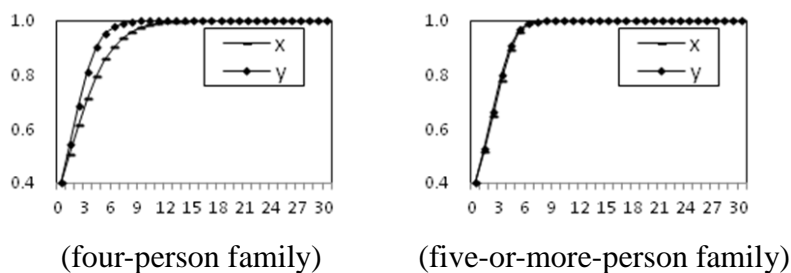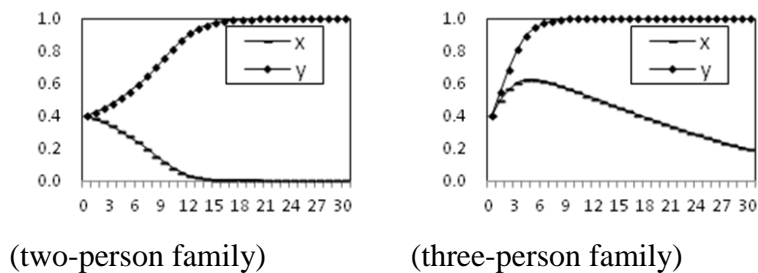

(two-person family)   (three-person family)

(four-person family)   (five-or-more-person family)

Fig 7: Impact of the return rate of a single generation's effort on evolution path of family migration

The impact of annual changes of α_1 and α_2 on the evolution path of family migration is analyzed. Comparing the four types of families in Figure 7 and Figure 2, when the revenue rate α_1 and α_2 of efforts made by the first generation or the second generation increases by 7%, the time required for system evolution to converge to the ideal state ($x = y = 1$) is respectively 6 years (for two-person families), 13 years (for four-person families), and 9 years (for five-or-more families); that is increased from 5 to 7 years(for three-person families). Except for three migrant families, α_1 and α_2 both lack flexibility. It can be seen that although the rate of return of a single group's efforts of the first and second generations has increased and the family migration may be realized after a period of time, the evolution process of family migration cannot be significantly accelerated.

4.2.3 Impact of purchase costs of commercial housing on the evolution path of inter-generational family's migration

The data of the experimental group is set. According to the general price level of commercial housing in 8 provinces and cities surveyed in 2017, it assumes each family has 100 square meters of housing area and the benefits and costs are allocated to 30 years, and then the rent of each household is deducted. It is determined that the benefits and costs of single-generational efforts of families in which only one generation makes efforts need to increase by 20,000 Yuan. The benefits and costs are evenly shared in the families with two generations working together and those of each generation need to increase by 10,000 Yuan. And then the data is simulated.
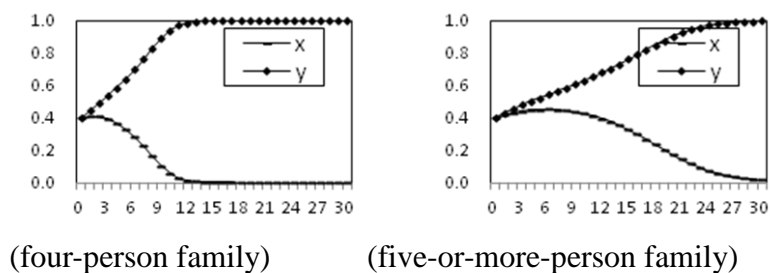

(two-person family)   (three-person family)

(four-person family)   (five-or-more-person family)

Fig 8: Impact of house purchase costs on the evolution path of family migration

Comparing the four types of households in Figure 8 and Figure 2, it is considered that migrating families purchase commercial houses to settle in cities. When the cost of buying houses of each generation increases, inter-generational migrating families cannot settle in cities within 30 years of their life cycle. It can be seen that the cost burden of urban commercial housing purchase at this stage is the biggest obstacle in the process of family migration and settlement in cities. According to calculations, migrant families who purchase commercial houses to settle in cities must first maintain rural-urban mobility or keep renting houses. About 70% of migrant families need 10 years and nearly 30% of families need 20 years to be able to purchase housing. Therefore, in order to solve the housing problem of migrant families who settle in cities, it is necessary to share the financial budget of cities at all levels and increase public housing and other affordable housing. However, the problem at this stage is that the fiscal sharing and incentive mechanisms of cities at all levels have not been fully established, the "people-land-money" connection system has not been fully implemented and the resettlement and protection of the rural 'three rights' of migrant families and the market-based exit mechanism are imperfect. And therefore, rural rights and interests have not been converted into capital for migrant families to settle in cities.

V. CONCLUSIONS AND POLICY IMPLICATIONS

Studies show that it is easier for inter-generational migrant families to realize family migration due to the advantages of two generations working simultaneously. However, due to the differences in the structure of labor and non-labor members of families with different population, it still takes several years to ten years to achieve family migration. Therefore, inter-generational migrant families should make full use of the advantages of having two generations working simultaneously to shorten the time of family migration. From the perspective of macro perspective, we can take full advantage of the interaction between family migration and inter-generational migration, and promote more than 40% of inter-generational migrant families to settle in cities, so as to achieve the goal of 100 million migrant workers settling down in cities quickly.

System simulation also shows that the evolutionary process of inter-generational migrant families from urban-rural migration to family migration is affected by the benefits of the first and second generations' mobility, by the return rate, marginal costs and spillover benefits of single-generational efforts, and by the return rate of two-generational joint effort (including 10 variables). It is shown that the benefits of the first and second generations' mobility and the return rate of single-generational efforts should be increased, and marginal costs and spillover benefits of single-generational efforts should be reduced to promote the two

1467

generations to work together to achieve family migration and increase the return rate of joint efforts. The above will promote inter-generational migrant families to evolve to family migration. The elasticity analysis further shows that if the process of family migration is to be accelerated, it is necessary to increase the benefits of urban-rural mobility of inter-generational migrant families, to reduce marginal costs and spillover benefits of single-generational efforts, and to promote two generations to work together to achieve family migration and increase the return rate of joint efforts. However, if the purchase of commercial housing in order to settle in cities is considered, inter-generational migrant families cannot settle in the city. The cost burden of housing purchase is the biggest obstacle in the process of family migration.

Therefore, in order to realize the evolution of inter-generational migrant families to family migration, the following aspects should be paid attention to when the citizenization policy in China is implemented. First, migrant families, Chinese governments, and other parties should invest in the fields such as improving the skills training of agricultural migrants, implementing the integration of training and employment, and reducing the structural contradictions between migrant worker's skills and industrial structure transformation and upgrading. Second, the policy of the household registration system should be implemented. The social welfare gap between urban and rural areas and that among different regions should be gradually eliminated, which are related to household registration. It is needed to continue to promote the implementation of six basic public services and seven conveniences for residence permits. Third, the equalization of public services such as social security, children's education, and housing security and so on should be accelerated. It is also needed to solve the problem of transfer and convergence of social security, expand the coverage of the security system of urban housing and housing provident fund, optimize education resources, and solve the problems of post-enjoyment of compulsory education and resolve the problem of burden of non-compulsory education. Fourth, the link system of 'people-land-money' and the exit mechanism for the protection of rural rights and interests should be implemented.

ACKNOWLEDGEMENTS

REFERENCES

[1] Han Jun (2009). Research on the Strategic Problems of Chinese Migrant Workers. Shanghai: Shanghai Far East Publishing House, 5.

[2] Zhou Hao (2004). Family trend and influencing factors of China's population migration. Population Research, 6: 60-69.

[3] Schwarzweller H. K (1964). Parental family ties and social integration of rural to urban migrants. Journal of Marriage and the Family, 26: 410-416.

[4] Sandell S. H (1977). Women and the economics of family migration. The Review of Economics and Statistics,

59(4): 406-414.

[5] Mincer J (1978). Family migration decisions. Journal of Political Economy, 86 (5): 749-773.

[6] Stark, O (1991). Migration in less development countries: risk, remittances and family. Finance and Development, 28(4): 431-452.

[7] Stark, O. and Taylor J.E. (1991). Migration incentives, migration types: the role of relative deprivation. The Economic Journal, 101(408): 1163-1178.

[8] Cooke T. J. and Bailey A. G. (1996). Family migration and the employment of married women and men. Economic Geography, 72: 38-48.

[9] Tervo H. (2000). Migration and labor market adjustment: empirical evidence from Finland 1985-1990. International Review of Applied Economics, 14(3): 343-360.

[10] Ritsila J and Tervo H (1999). Regional differences in the role of migration in labor-market adjustment: the case of Finland, in G. Crampon (ed.) regional unemployment, job matching and migration. Series on European Research in Regional Science. London: Point Limited: 166-182.

[11] Nivalainen S (2004). Determinants of family migration: short moves vs long moves. Journal of Population Economics, 17: 157-175.

[12] Swain L L and Garasky S (2007). Migration decision of dual-earner families: an application of multilevel modeling. Journal of Family Economics Issue, 28: 151-170.

[13] Geist C and Mc Mamus P A (2012). Different reasons, different results: implications of migration by gender and family status. Demography, 49: 197-217.

[14] Zhao Y.H (1999). Leaving the countryside: rural-to-urban migration decision in China. American Economic Review, 89(2): 281-286.

[15] Jalan, J and Ravallion M (2001). Behavioral responses to risk in rural China. Journal of Development Economics, 66(1): 269-283.

[16] Xu H. and Y. Xie. (2015). The causal effects of rural-to-urban migration on children's well-being in China. European Sociological Review, 31(4): 502-519.

[17] Li Qiang (1996). Research on the family model of migrant workers. Zhejiang Academic Journal, 1: 5.

[18] Du Ying and Bai Nansheng (1997). Coming out of the Country--An Empirical Study of Rural Labor Mobility in China. Beijing: Economic Science Press: 5.

[19] Yu Xuejun (2014). Characteristics and needs of China's migrant population and public policy thinking. Open Leader Journal, 6: 20-23.

[20] Sheng Yinan (2014). Relocation model of families in China. Population Research, 3: 41-54.

[21] Chen Xianshou (1996). Analysis on migrant families and corresponding countermeasure. Chinese Population Science, 5: 4.

[22] Zhai Zhenwu (2009). The latest situation and analysis of migrant population in Beijing. Population Reasearch, 2: 30-40.

[23] Zhu Mingfen (2009). The migration patterns and influencing factors of migrant workers' families. Chinese Rural Economy, 2: 67-76.

[24] Tang Zhen (2009). The influencing factors of farmers' migration mode in the process of urbanization: an empirical analysis based on Nanjing City, Jiangsu Province. Agricultural Technology Economy, 4: 4-11.

[25] Xu Qinghong (2015). The status of Yunnan's migrant population's family relocation--based on the data of Yunnan Province's 2013 dynamic population survey. Northwest, 2: 87-91.

[26] Chen Suqiong (2017). Changes of family-migration models of urban migrant workers and their happiness effects -- a study based on CGSS data. Agricultural Technology Economy, 8: 67-80.

[27] Hong Xiaoliang (2007). Research on the family migration behavior of urban migrant workers and its influencing factors. Chinese Population Science, 6: 42-50.

[28] Duan Chengrong (2013). The main problems and countermeasures of China's migrant population: based on the data of the sixth national census in 2010. Population Research, 2: 17-24.

[29] Wu Fan (2016). Migration sequence of Chinese migrant families and its policy implications. Journal of Nankai (Philosophy and Social Sciences Edition), 4: 103-110.

[30] Friedman D (1991). Evolutionary game in economics. Econometrics, 5: 637-666.

[31] Sun Zhanwen and Yang Xuecheng (2014). Static analysis of migrant families' migration decision in the process of citizenization. Agricultural Technology Economy, 7: 36-48.