Income Growth of Peasants Based on Grey Theory

TAO Ai-xiang *

Huaiyin Institute of Technology, Huaiyin 223001, China

Abstract Taking Jiangsu Province for example and using the relevant data in *Jiangsu Statistical Yearbook* and *Statistical Communique of Jiangsu Province on National Economic and Social Development* during 2002 -2009, the thesis selects eight indexes including per capita net income of farmers, the fixed asset investment level in rural areas, average educational level, agricultural scientific and technological level, urbanization level, industrialization level, average consumption level per rural residents and per capita GDP and adopts the theory of grey correlation to analyze the factors influencing the peasants' net income. As shown in the result, the effect on the peasants' net income gives the following subsequence from great to little: average consumption level per capita of rural residents, urbanization level, average educational level, industrialization level, per capita GDP, number of scientific and technical personnel and fixed asset investment level in rural areas, that is, $r_{06} > r_{04} > r_{02} > r_{05} > r_{07} > r_{03} > r_{01}$. Then combining with the practical conditions, the thesis makes a detailed analysis of each factor influencing the peasant's income growth and proposes corresponding measures in order to improve the peasants' income.

Key words Peasant's income, Grey correlation, Problems concerning agriculture, rural area and rural people, Per capita net income, China

Since the 21st century, the central government has been promulgating the ideas and methods in the " central first documents" to solving the problems concerning farmers, rural areas and agriculture for six years, which shows that the central government attaches great importance to these problems especially how to improve the peasants' income. Although these documents and policies have increased the farmers' income to a certain degree, there are also some factors constraining their income growth and the urban-rural gap is still large, based on this, according to relevant data about the per capita net income, the author takes Jiangsu Province for example, adopts the grey correlation theory and discusses the issue of increasing the farmers' incomes.

1 Data source, model establishing and index selection

1.1 Data source

1.1.1 Per capita net income of farmers. The per capita net income of farmers refers to the balance after deducing the household daily expenditure, taxes, the depreciation of fixed assets for production purpose and those given to the friends and relatives from the total annual income of a rural household from all sources (including physical income), it is denoted as x_0.

1.1.2 Fixed asset investment level in rural areas. The fixed asset investment level in rural areas lays the foundation for rural social and economic development, only with a firm foundation could the potential for the income growth of rural residents be fully exploited, the research will choose the rural fixed asset investment amount to measure the investment level, it is denoted as x_1.

1.1.3 Average educational level. It has been confirmed by foreign academics that education is an important approach to enhancing the human capital as well as the most powerful support for increasing the incomes. The stagnated growth of farmers' income is directly related to the backward rural education to a large degree, the backward rural education directly affects the improvement of the farmers' scientific and cultural quality. The average education level will be measured by the percentage of the people with junior middle school or higher education, and it is denoted by x_2.

1.1.4 Agricultural scientific and technological level. The agricultural scientific and technological level has a significant effect on modern agriculture, the advanced agricultural science and technology could improve the farmers' income level. Here it will be measured by the number of the talents in agricultural science and technology, which is denoted by x_3.

1.1.5 Urbanization level. Urbanization level is an important indicator of the economic development, social organization degree and management level in a country or region, it is denoted by x_4.

1.1.6 Industrialization level. Industrialization level generally refers to the process of traditional agricultural society transforming into modern industrial one. It is also a transition from the agriculture-based economy with backward production technology and low productivity to the advanced industry-based economy with advanced production technology and highly-developed social productivity. The industrial level is referred to as x_5.

1.1.7 Average consumption level per rural residents. Consumption and production are closely linked, production determines consumption, while consumption has a strong reaction on production, and it is one of the important factors promoting the economic growth and the farmers' income growth. Here this index is denoted by x_6.

1.1.8 Per capita GDP. Per capita GDP is often adopted to measure the economic conditions in the development economics, it is one of the indicators of macro economy and an effective tool for people to understand and grasp the macro economic conditions in one country or region, here is referred to as x_7.

Received: May 28, 2010 Accepted: June 16, 2010

* Corresponding author. E-mail: taxzfytq@yahoo.com.cn

1.2 Data source The data comes mainly from the relevant data in *Jiangsu Statistical Yearbook* and *Statistical Communique on the National Economic and Social Development of Jiangsu Province* during 2002 –2009 (Table 1).

Table 1 The factors influencing the per capita net income of peasants in Jiangsu Province during 2002 –2008

Year	x_0 // Yuan	x_1 // $\times 10^4$ Yuan	x_2 // %	x_3 // $\times 10^4$	x_4 // %	x_5 // %	x_6 // Yuan	x_7 // Yuan
2002	3 995.6	830.3	46.77	3.74	44.7	61.2	3 817.4	14 396
2003	4 239.3	1 325.1	47.12	3.74	46.8	67.2	3 858.6	16 830
2004	4 753.9	1 819.4	49.87	3.25	48.2	63.6	4 414.1	20 223
2005	5 276.3	2 527.8	50.07	3.18	50.5	61.8	5 281.3	24 560
2006	5 813.2	2 589.9	52.78	3.11	51.9	60.5	5 842.3	28 814
2007	6 561.3	3 107.6	54.47	2.92	53.2	59.7	6 850.2	33 928
2008	7 356.5	3 690.7	57.13	3.06	54.3	60.4	7 484.3	39 622

1.3 Model establishing Due to the difficulty in collecting the statistical data, the traditional regression analysis method cannot accurately measure the effect, however, as an scientific method to analyze the data under the circumstance of incomplete information, the grey theory remedies the defect of mathematical statistics in the systematic analysis, which is applicable no matter the sample amount is large or small and whether the samples are regular or irregular, moreover, since it is with less calculation and convenient to use, there will be no such situation that the quantitative results are not in accordance with the qualitative analysis, so this theory is suitable to analyze the factors influencing the peasants' incomes. The steps of establishing the grey correlation dynamic analysis model are as follows:

(1) The establishment of the reference sequence of dependent variable and comparative sequence of independent variable in the original sequence. The reference sequence of dependent variable is also called parent sequence, denoted as $x_0^{(k)}$: $x_0^{(k)} = [x_0^{(1)}, x_0^{(2)}, x_0^{(3)}, \cdots, x_0^{(k)}]$; while the comparative sequence of independent variable is also called sub-sequence, denoted as $x_i^{(k)}$:

$$x_i^{(k)} = [x_i^{(1)}, x_i^{(2)}, x_i^{(3)}, \cdots, x_i^{(k)}], (i = 1, 2, 3, \cdots, n)$$

(2) The dimensionless processing of original sequence. This aims to eliminate the impact caused by different orders of magnitude so as to make it easy to conduct calculation and comparison. The dimensionless processing could be achieved through the means of initialization, mean values and interval values, the calculation formula is as follows:

$$x_i^{(k')} = x_i^{(k)} / x_i^{(1)},\ x_i^{(k')} = x_i^{(k)} \sqrt{x_i}$$

(3) The evaluation of difference sequence, maximum value and minimum value. The difference sequence is: $\Delta_i = [\Delta_i(1), \Delta_i(2), \Delta_i(3), \cdots, \Delta_i(k)]$, the maximum value is :

$\Delta_{\max} = \max_i \max_i | x_0^{(k')} - x_i^{(k')} |$ while the minimum value is $\Delta_{\min} = \min_i \min_i | x_0^{(k')} - x_i^{(k)} |$

(4) The calculation of grey correlation coefficient. The formula is:

$$L_{0i}^{(k)} = \frac{\Delta_{\min} + \lambda \Delta_{\max}}{\Delta_i(k) + \lambda \Delta_{\max}}$$

in this formula $L_{0i}^{(k)}$ refers to the correlation coefficient between the NO. k number of the sub-sequence $x_i (i = 1, 2, 3, \cdots, n)$ and the parent sequence x_0, λ is the resolution coefficient, among the range 0 –1, generally λ takes the value of 0.5.

(5) The calculation of grey correlation degree. In order to obtain the total correlation degree, we should take into account the importance of each observation point in the overall observation, therefore we need to determine the weight of each point. Generally, the grey correlation degree is calculated by the means of arithmetic average, the formula is:

$$r_{0i} = 1/n \sum_{k=1}^{n} r_{0i}(k)$$

in this formula r_{0i} refers to the correlation coefficient between the sequence x_0 and sequence x_i.

(6) The ordering of the correlation degree. The correlation degree will be ordered according to the value of r_{0i}. The closer the correlation degree to 1, the greater the correlation degree. According to the experience, when $\lambda = 0.5$, the correlation degree is greater than 0.6, we can say that the correlation is significant[1-3].

2 Results and analysis

2.1 Calculation of grey correlation

(1) Normalization of data. In the correlation analysis, the advantage analysis could be conducted when there are more than one reference sequence and factor to be compared. Generally the reference sequence is called parent sequence (parent factor) while the comparative sequence is referred to as sub-sequence (sub-factor). In this paper, the parent sequence is x_0 and the sub-sequence is $x_1 - x_7$ (Table 1). Due to the different physical meanings of each factor in the system, the selected indexes do not share the same dimension or dimension unit, thus leading to the diversified dimensions of the data, which, as a result, makes it difficult to compare or to obtain the correct conclusion in the comparison, in order to make these indexes comparable, we should conduct a dimensionless processing of the data before calculation. The data in Table 1 are normalized by the means of initialization so as to change each index into comparable quantitative values, the results obtained from the normalization processing are shown in Table 2.

(2) The evaluation of the difference sequence. Taking x_0 as the parent sequence and each sequence as the sub-sequence, it calculates the absolute value of the difference between the parent sequence and the sub-sequence. The difference sequence is:

$\Delta 1 = (0, 0.534, 1.000, 1.722, 1.622, 2.098, 2.601)$
$\Delta 2 = (0, 0.054, 0.123, 0.250, 0.327, 0.477, 0.619)$
$\Delta 3 = (0, 0.061, 0.320, 0.471, 0.623, 0.861, 1.023)$
$\Delta 4 = (0, 0.014, 0.111, 0.192, 0.294, 0.452, 0.626\ 0)$
$\Delta 5 = (0, 0.037, 0.150, 0.312, 0.467, 0.667, 0.854)$
$\Delta 6 = (0, 0.050, 0.033, 0.062, 0.075, 0.152, 0.120)$

$\Delta 7 = (0, 0.108, 0.216, 0.385, 0.546, 0.715, 0.911)$

Δ_i is the difference sequence formed after the difference operation between the sequence $x_i (i = 1, 2, 3, \cdots, n)$ and the sequence x_0.

Table 2 The influence factors and initial values of per capita net income of peasants in Jiangsu Province during 2002 – 2008

Year	x_0 // Yuan	x_1 // $\times 10^4$ Yuan	x_2 // %	x_3 // $\times 10^4$	x_4 // %	x_5 // %	x_6 // Yuan	x_7 // Yuan
2002	1	1	1	1	1	1	1	1
2003	1.061	1.595	1.007	1	1.047	1.098	1.011	1.169
2004	1.189	2.189	1.066	0.869	1.078	1.039	1.156	1.405
2005	1.321	3.043	1.071	0.850	1.129	1.009	1.383	1.706
2006	1.455	3.117	1.128	0.832	1.161	0.988	1.530	2.001
2007	1.642	3.740	1.165	0.781	1.190	0.975	1.794	2.357
2008	1.841	4.442	1.222	0.818	1.215	0.987	1.961	2.752

(3) The evaluation of the maximum value and minimum value. $\Delta_{max} = 2.601$ and $\Delta_{min} = 0$, $\lambda = 0.5$.

(4) The evaluation of grey correlation degree. The grey correlation coefficient is calculated by the calculation formula of grey correlation degree (Table 3).

Table 3 The correlation coefficient between per capita net income of peasants and its influence factors in Jiangsu Province during 2002 – 2008

Year	L_{01}	L_{02}	L_{03}	L_{04}	L_{05}	L_{06}	L_{07}
2002	1	1	1	1	1	1	1
2003	0.709	0.960	0.955	0.989	0.972	0.963	0.923
2004	0.565	0.914	0.803	0.921	0.897	0.975	0.858
2005	0.430	0.839	0.734	0.871	0.807	0.954	0.772
2006	0.445	0.799	0.676	0.816	0.736	0.945	0.704
2007	0.383	0.732	0.602	0.742	0.661	0.895	0.645
2008	0.333	0.678	0.560	0.675	0.604	0.916	0.588

The calculated grey correlation degrees are $r_{01} = 0.552$, $r_{02} = 0.846$, $r_{03} = 0.761$, $r_{04} = 0.859$, $r_{05} = 0.811$, $r_{06} = 0.949$, $r_{07} = 0.781$.

(5) The ordering of the calculation degree. The above correlation degrees are all above 0.5, which shows that there is a strong correlation between each factor and per capita net income of rural people, the order is $r_{06} > r_{04} > r_{02} > r_{05} > r_{07} > r_{03} > r_{01}$.

2.2 The analysis of the grey correlation degree

(1) Per capita consumption level of farmers has the greatest impact on their incomes. This fully proves that the improvement of the consumption level is very important to the farmers' income growth, under current financial crisis, the international trade plays a limited role in stimulating the economy, while too much investment may produce excessive capacity and cause environmental pollution, thus, during a certain period of time to come, we should focus on improving the consumption level of both the urban and rural residents. For example, on the basis of the subsidies to home appliances going to the countryside in 2009, the government will increase both the scope and proportion of the subsidy dramatically in 2010, especially to improve the subsidies to agricultural machineries, moreover, the government further enhances the subsidies to the automobiles and building materials going to the countryside. These measures will effectively promote the farmers' consumption level. However, it should not be neglected that the overall income of rural residents is not high, which on the one hand constrains the improvement of the consumption level and on the other hand confronts the farmers with the difficulties in the supporting of old people, medical treatment and education of the children. Therefore, we should adopt more effective policies and boost the investment in the social security of rural residents so as to remove their worries.

(2) The urbanization level has great impact on the farmers' income. This conclusion further proves the correctness of the statement that we can get the farmers rich through reducing their number. To accelerate the pace of urbanization, loose up the restrictions on the farmers' settlement in urban areas, pay more attention to the construction of small towns and transform the farmers in their local regions all call for relevant supporting measures involving the household registration reform, land reform, financing reform and so on.

(3) The farmers' education level largely determines their income. This indicates that, in order to greatly increase their incomes, we should make great efforts in improving their education level. the government should keep enhancing rural compulsory education from a long-term point of view on the one hand, while provide specific trainings to the farmers according to market demands for personnel during a period of time in the future on the other hand, so that the trained skills of the farmers would be useful. The main problems at present are the blindness of the training as well as poor organization and coordination, as a result, many rural residents lack the enthusiasm for training.

(4) Industrialization level has relatively large impact on the farmers' incomes. The development of industry could create more wealth and provide more job opportunities for the farmers, so we should keep promoting the process of industrialization. Moreover, the per capita GDP has a significant impact on the farmers' incomes, which indicates that the maintenance of a high economic growth rate could promote a sound and rapid economic development.

(5) Agricultural scientific and technological level exerts certain impact on the farmers' incomes. There is a low correlation degree between the number of scientific and technological personnel and per capita net income of farmers, because the contribution rate of the first industry to the GDP in Jiangsu Province is declining year by year, and the proportion of the agricultural income is also decreasing year by year, which indicates from another aspect that only by enhancing the role of agricultural science and technology in modern agriculture can the

farmers' income be effectively improved.

(6) Fixed asset investment level in rural areas has no big influence on the farmers' income. Since there are little programs which could directly promote the farmers' income growth in the fixed asset investment of urban areas except for some infrastructure construction, the effectiveness of which, however, obviously delay. Therefore, we should increase the investment in rural areas on those programs which could directly improve the farmers' incomes.

3 Conclusion

There are a lot of factors influencing the growth of the farmers' income, so in order to keep a continuous growth of the farmers' income, a long-term mechanism must be established. We should find out the main influencing factors and then sustain them through formulating corresponding policies and regulations so as to promote the continuous growth of the income. To be specific, currently we should focus on improving the per capita consumption level of the farmers and accelerating the pace of urbanization and industrialization, meanwhile improving rural scientific and technological level as well as the farmers' education level. The current consumption level in our rural areas is still not high, although the government has offered subsidies to the home appliances going to the countryside, the farmers' worries are still not completely eliminated. And thus the consumption of the farmers has still not achieved the desired level. Therefore, the government should take further measures to enable farmers to consume without worries. It should enhance the support for rural endowment insurance policies and expand the coverage and amount of money of the rural medical insurance. Moreover, reduce the education costs of rural residents, relax the restriction on the farmers' coming into city so as to promote the orderly flow of farmers. The integrated measures enable a steady growth in peasants' incomes.

References

[1] LIU SF, GUO TB. Grey system theory and its application[M]. Zhengzhou: Henan University Press, 1991. (in Chinese).
[2] YI DS, GUO P. Grey theory and method[M]. Beijing: Petroleum Industry Press, 1992. (in Chinese).
[3] DENG JL. The basis of grey theory[M]. Wuhan: Huazhong University of Science and Technology Press, 2002. (in Chinese).
[4] ZHANG L. Empirical analysis on fixed assets investment and income increase of rural household[J]. Asian Agricultural Research, 2009, 1(4): 1-4.
[5] FENG XM, WNAG J, YUE K. Analysis on effects of county-level city development on farmers' income[J]. Journal of Anhui Agricultural Sciences, 2010, 38(15):516-518, 555. (in Chinese).
[6] GUAN LL, MEN KP. Cluster analysis on per capita net income of rural households in China[J]. Asian Agricultural Research, 2009, 1(6):1-3, 9.
[7] OU LJ, HU AS, LI BH. Study on planting mode of farmland on water and fish in water[J]. Journal of Anhui Agricultural Sciences, 2010, 38(12):309-310, 483. (in Chinese).
[8] GE F, HUANG J, MU YY. Comparative analysis on the effects of income structure on consumption level of rural residents in eastern and western China: A case study on Jiangsu and Xinjiang Province[J]. Asian Agriculture Research, 2009, 1(8):1-5.
[9] WEI KY. Analysis on the influence of sugarcane industry on increasing peasant income in Guangxi[J]. Journal of Anhui Agricultural Sciences, 2010, 38(12):500-502. (in Chinese).

(From page 17)

cow breeding, pollution-free vegetable, flower and plant product, and tobacco planting. Three industries should be developed, so as to comprehensively promote the development of Mengjin County. Thirdly, Xinan County and Yiyang County have various land types of mountain, hilly and valley. Therefore, large-scale enterprises should be made full use of to realize the development of counties. Fourthly, based on the existing industrial system, Song County should make use of Funiu Mountain, Waifang Mountain, Xionger Mountain, Yi River, Ru River, and Bai River to vigorously develop tourism, and to stress on both industry and tourism. Fifthly, Ruyang County is rich in specialty and resources with more than 200 types of economic forests. It is the planting base of national high-quality tobacco and peanut. Therefore, driving mode of agricultural industrialization leading enterprise should be adopted. Sixthly, Luoning County should adopt the rural characteristic planting mode because it is a typical mountainous agricultural county. Seventhly, Yichuan County is rich in resources with 37 types of minerals. Therefore, it should expand and strengthen mineral enterprises and promote the development of urbanization.

5 Conclusion

Urbanization is the need for modernization, an effective means for the rapid economic development of mountain area and underdeveloped area, and the major route to solve the "Three Agricultural Problems". Due to the low urbanization level, limited radiation of central city and the unbalanced development of counties, development mode of rural urbanization in Luoyang City should take the road of diversified small towns according to their own advantages[6].

References

[1] Henan Province Statistics Bureau. 2008 Henan statistical yearbook[M]. Beijing: China Statistics Press, 2008. (in Chinese).
[2] ANON. Historical evolution of Luoyang[EB/OL]. (2008-03-18). http://www.jxq.gov.cn/zjjx/200803/12285.shtml. (in Chinese).
[3] Luoyang Statistics Bureau. 2009 Luoyang statistical yearbook[M]. Beijing: China Statistics Press, 2009. (in Chinese).
[4] LI ZN, YE AZ. Advanced econometrics[M]. Beijing: Tsinghua University Press, 2000:104-107. (in Chinese).
[5] HU SY. China's urbanization development strategy[M]. Beijing: Press of Party School of the Central Committee of C. P. C., 2002: 80-81. (in Chinese).
[6] HU BL. Is rural urbanization equal to the urbanization[EB/OL]. (2007-08-13). http://www.chinapop.gov.cn/rklt/llt/200708/t20070815_49709.htm. (in Chinese).