 DOI: 10.19601/j.cnki.issn1943 - 9903.2017.12.003

Evaluation of Development Level of New Four Modernizations Based on Gray Relational Model——A Case Study of 14 Cities in Hunan Province

Naman YANG[1,2]*

1. Institute of Industrial Economics, Chinese Academy of Social Sciences, Beijing 100836, China; 2. Party School of the Organs Directly Under the Hunan Provincial Committee of CPC, Changsha 410001, China

Abstract The development level of industrialization, informationization, urbanization and agricultural modernization (New Four Modernizations) is an important indicator for evaluation of regional economic development. In this paper, an indicator system was designed for evaluation of the development level of New Four Modernizations according to the interaction mechanism between them. It introduced the data related to New Four Modernizations of 14 cities in Hunan Province during 2004 and 2012, and made a comprehensive analysis of the development level of New Four Modernizations in these cities by entropy-gray relational method. It found that the development level of New Four Modernizations in 14 cities in Hunan Province was extremely uneven, and the stronger would become stronger, while the weaker would become weaker, like Matthew effect. Thus, it is required to straighten out the development idea, carry out reform and innovation in the mechanism construction, urban-rural integration, interaction and integration, and regional coordination, to promote simultaneous development of New Four Modernizations.

Key words New Four Modernizations, Evaluation, Entropy, Gray relational analysis

1 Introduction

In the *Report to the* 18*th National Congress of the Communist Party of China*, the path of China's economic development was summarized as simultaneous development of Four Modernizations, in other words, taking the road of new industrialization, informationization, urbanization and agricultural modernization with Chinese characteristics to realize common progress. Compared with the traditional Four Modernizations, New Four Modernizations are new connotation given to the modernizations in the new period. They are interrelated and inseparable. Only through realizing the simultaneous development of New Four Modernizations, can we realize the objective of socialist modernization construction. The simultaneous development of New Four Modernizations is a new research topic, there are few findings; therefore, this study is of great theoretic and practical significance for enriching contents of New Four Modernizations and promoting simultaneous development of New Four Modernizations.

In foreign countries, the industrialization first developed, it then promoted the development of agriculture and urbanization. In the middle and later period of the 20th century, the informationization started development. In theoretical researches, it was also this sequence. The researches about Four Modernizations were mainly concentrated on industrialization and economic growth, between agricultural modernization and industry and agriculture, between urbanization and anti-urbanization, and informationization. There was no literature about simultaneous development of Four Modernizations, but researches were very systematic, forming the theory of economic growth and theory of relationship between industry and agriculture. The most representative study is Lewis's dual economy model[1], Hoffman Theorem put forward by German economist Hoffman in his book *Stages and Types of Industrialization*[2], Rostow's Stages of Economic Growth theory[3], and multinational model of American economist Chenery[4].

In recent years, many domestic scholars have studied industrialization, urbanization, informationization and agricultural modernization, most studied one or several modernizations, some studied the interaction between New Four Modernizations, policy measures for realization of interactive development of New Four Modernizations, and some made empirical researches of the development level of New Four Modernizations. For example, Xu Jun *et al.*[5] defined the basic connotation of New Four Modernizations according to strategic thought of simultaneous development New Four Modernizations put forward in the *Report to the* 18*th National Congress of the Communist Party of China*, systematically studied the coupling and interaction mechanism and rules of four modernizations, established a coupling relation model, to provide theoretical basis for simultaneously promoting New Four Modernizations, realizing deep integration of informationization and industrialization, and benign interaction of industrialization and new urbanization, and coordination of new urbanization and agricultural modernization. Xu Dawei *et al.*[6] straightened out and theoretical demonstration of the relationship between industrialization, urbanization and agricultural modernization, and stated that industrialization is the means of agricultural economic development, urbanization is the external manifestation of agricultural economic development, and agricultural modernization is the objective of agricul-

Received: November 7, 2017 Accepted: December 10, 2017
Supported by Key Project of Philosophy and Social Science Foundation of Hunan Province (13ZDB11); Project of Philosophy and Social Science Foundation of Hunan Province (12YBA281); General Project of Hunan Provincial Situation Decision-making Consulting Issues (16JCD047); 2017 Social Science Planning Project of Hunan Provincial Party School System and Administration College System (2017DX005).
* Corresponding author. E-mail: ynm2535@163.com

tural economic development. Wu Yayan analyzed on how to formulate a statistical indicator system for evaluating the realization degree of new industrialization in China[7]. Chen Senliang *et al.*[8] established a statistical indicator system for new industrialization including 24 indicators such as per capita GDP, urbanization level, and degree of informationization. Based on relevant economic data of all provinces (cities and regions) in China, Shi Rong *et al.*[9] built a comprehensive evaluation indicator system for informationization development level, made an evaluation and comparison of informationization development level of all provinces by factor analysis and cluster analysis, and came up with pertinent measures and recommendations, to improve the understanding of regional informationization construction level and provide a scientific basis for formulating policies of informationization construction. With the reference to the indicator system proposed by Xin Ling and Jiang Heping, Shen Qi *et al.*[10] replaced the original AHP with the factor analysis method, effectively overcame the high subjectivity in the weight setting, and finally the calculation results indicated that the simplified indicator system has the same evaluation results as the original indicator system in the evaluation of development level of modern agriculture. Through constructing simultaneous equations of urbanization and economic growth panel data, and using the GMM three-stage least-squares method, Zhang Mingdou[11] made an empirical analysis of the endogenous relationship between urbanization and economic growth in 30 provinces and autonomous regions in China during 2002 and 2011, the results indicated that the function of urbanization level for economic growth took on an inverted U-shaped relationship. Yuan Xiaoling *et al.*[12] measured and evaluated the interactive relationship of New Four Modernizations in China, and the results showed that industrialization and informationization, industrialization and urbanization, urbanization and informationization, urbanization and agricultural modernization realized excellent interaction, while the industrialization and informationization did not realize excellent interaction with agricultural modernization. Shao Yu *et al.*[13] introduced six major supports for new urbanization. According to the study of Huang Ansheng *et al.*[14], on the whole, few provinces have realized coordinated development of New Four Modernizations and all these cities are located in eastern coastal developed areas; from the perspective of coordinated and simultaneous development of New Four Modernizations, most provinces including eastern areas have some shortages in the simultaneous development of New Four Modernizations. With the reference to the theory of system dynamics, Jiang Yixian *et al.*[15] analyzed the connotation of simultaneous development of New Four Modernizations, plotted the cause and effect feedback loop drawing for relationship between either two modernizations, and designed SD model simulation and emulation idea of simultaneous development of four modernizations. Ma Dejun *et al.*[16] analyzed and pointed out that the development of urbanization and agricultural modernization in the western regions mainly experienced the process of "imbalanced-coordinated-imbalanced-coordinated"; in future, the urbanization in western regions will continue developing, agricultural modernization will also get improved, and the coordinated development between them will step to a higher level. Ruan Jiagang[17] carried out a dynamic evaluation of the simultaneous development of four modernizations; in the survey period, there was no obvious improvement in the simultaneous development of four modernizations, few provinces had high level of simultaneous development, most provinces had obvious one or two backward modernizations; the simultaneous development of four modernizations generally took on the pattern of high in west, low in east, high in north and south, and low in central regions. The above researches are from national or regional perspective. Following researches are from provincial perspective. Huang Xiangfang *et al.*[18], taking 11 prefecture-level cities of Jiangxi Province during 2003 and 2012 for example, made a quantitative analysis on the coupling coordinated development of four modernizations, and the results indicated that the coupling coordination of four modernizations in 11 prefecture-level cities of Jiangxi Province slowly increased in fluctuation. Fang Hua[19] carried out an empirical study on the coordination of four modernizations in Guangdong Province, and the analysis indicated that the overall coordination of four modernizations in Guangdong during 2003 and 2012 was low, the development of agricultural modernization system was not consistent with other three modernizations, and the coordination between urbanization and informationization declined. Zhang Yabin[20] analyzed the constraints and general trend of the coordinated development of four modernizations in Guangxi and came up with recommendations for coordinated development of four modernizations in Guangxi. Xiao Yanxue[21] estimated the development level and coordinated development degree of agricultural modernization, urbanization, industrialization and informationization in reclamation area of Heilongjiang, and stated that the development of industrialization will be the main driving force for coordinated development of four modernizations in reclamation area of Heilongjiang.

In summary, due to simultaneous coverage of four modernizations in China, theoretical studies are concentrated on one, two or three modernizations. However, there are few researches about the simultaneous development of four modernizations. In China National Knowledge Infrastructure (CNKI), papers about development level of four modernizations are few. Except studies from state macro perspective, all others are based on regional or provincial perspective, but there is no quantitative research about the development level of New Four Modernizations in Hunan Province. According to the interaction mechanism between industrialization, informationization, urbanization and agricultural modernization, we designed an evaluation indicator system and introduced the data related to New Four Modernizations in 14 cities of Hunan Province during 2004 and 2012, and made a comprehensive analysis of the development level of New Four Modernizations in these cities by entropy-gray relational method, to solve the problems of shortage of the above researches.

2 Design of evaluation indicator system for development level of New Four Modernizations

2.1 Selection of the evaluation indicators Different from the traditional four modernizations, the New Four Modernizations are a complex, closely linked and multi-level system, and it emphasizes mutual cooperation and coordination to promote common and coordinated development.

Therefore, for the entire system of New Four Modernizations, in a period $[t_1, t_2]$, if using x to denote the description indicator reflecting the local comprehensive development level, the development means "there exists t, and $x_{t+1} > x_t$"; the local comprehensive development level means "for any t, $x_{t+1} > x_t$ stands", namely, $x_{t+1} > x_t$, $t \in [t_1, t_2]$, where $[t_1, t_2]$ is domain of definition of x. In other words, x is the period of the development level indicator.

To achieve sustainable development of New Four Modernizations, it naturally means constant extension of the time t. When t exceeds the domain of definition $[t_1, t_2]$ of specific local comprehensive development level, the development of local comprehensive development level with x as the development indicator becomes impossible. Then, it is possible to use indicators different from x to depict the local development level. This is the local comprehensive development in the sense of development indicator conversion. For the system of New Four Modernizations, after completion of a round of development, it starts a new round of coordinated development under different development indicators, to realize the benign development: industrialization creates supply, urbanization generates demands, industrialization is the foundation and driving force of urbanization, while urbanization in turn promotes constant development of industrialization, and then promotes traditional agriculture, drives and outfits modern agriculture, while agricultural modernization provides support and guarantee for industrialization, informationization and urbanization.

Based on the above analysis, the design of evaluation indicators should comply with the following principles: relative completeness principle, scientific principle, regional difference principle, operability principle, relative independence principle, dynamic and stability combined principle, comparability principle, and adaptability principle.

2.2 Design of evaluation indicator system for development level of New Four Modernizations The evaluation indicator system for the development level of New Four Modernizations includes four elements: industrialization system, informationization support system, urbanization support system and agricultural modernization support system. The above four elements run through the whole process of the development of New Four Modernizations and interact with each other to form an organic whole. These four elements are also the four Level I indicators of the established indicator system. Since the data of some indicators are not available, we removed those indicators and finally obtained the evaluation indicator system (Table 1).

Table 1 Evaluation indicator system for development level of New Four Modernizations

Level I indicator	Level II indicator	Unit
Industrialization evaluation indicators	Per capita GDP	Yuan
	Proportion of added value of non-agricultural industries to GDP	%
	Proportion of non-agricultural workers to all workers	%
	Output value of comprehensive utilization products of three kinds of wastes	10^4 Yuan
	Number of domestic invention patents	Item
	Full time equivalent of R&D personnel	Man-year
	Proportion of number of large and medium-sized industrial enterprises to the number of industrial enterprises and production units	%
	Industrial wastewater up-to-standard discharge	%
Informationization evaluation indicators	Telephone penetration rate	Set/100 persons
	Mobile phone penetration rate	Set/100 persons
	Comprehensive population coverage of TV program	%
	Comprehensive population coverage of Radio program	%
	Added value of electronic information manufacturing industry	10^8 yuan
	Number of workers of electronic information manufacturing industry	10^4 persons
	Total profit of electronic information manufacturing industry	10^8 yuan
Urbanization evaluation indicators	Percentage of urban population	%
	Urban registered unemployment rate	%
	Engel coefficient of urban households	%
	Per capita disposable income of urban households	Yuan
	Urban road area per capita	m^2/person
	Public transport vehicles per 10 000 persons	Standard set/10^4 persons
	Number of students in higher education institutions	10^4 persons

(To be continued)

(Continued)

Level I indicator	Level II indicator	Unit
	Urban water penetration	%
	Hospital beds per 10 000 persons	Pcs
	Per capita living space in urban area	m^2
Agricultural modernization evaluation indicators	Total power of agricultural machinery	10^4 kW
	Effective irrigation area	10^3 ha
	Chemical fertilizer application	10^4 t
	Rural power consumption	10^8 kWh
	Generating capacity of hydropower station in rural areas	10^4 kW
	Total sown area of crops	10^3 ha
	Per capita grain yield	kg/person
	Grain yield per unit area	kg/ha
	Proportion of number workers of the primary industry to all workers	%
	Proportion of added value of the primary industry to GDP	%

3 Evaluation of the development level of New Four Modernizations in Hunan Province

3.1 Data collection and processing Since the accuracy and authority of data collection will directly affect the accuracy of the evaluation results, the data for this evaluation system need to be obtained from authorities. Most data were obtained and calculated from the *Statistical Yearbook of Hunan Province* (*2004 – 2012*), and the rest data were collected and calculated from statistical communiqué of cities (prefectures) of Hunan Province.

Generally, the indicators can be divided into the following types according to the indicator nature: the benefit type (such as profit and yield, the indicator value is proportional to the benefit); the cost type (the indicator value is inversely proportional to the benefit); the fixed type (the indicator value is relatively stable, basically at a fixed value). According to the different nature of the indicators, we made different data conversion pertinently. Usually, the benefit type indicators can be normalized as formula (1), the cost type indicators can be normalized as formula (2), where $x_{max}(j)$ and $x_{min}(j)$ denote the maximum value and minimum value of $x(j)$; the fixed type indicators can be normalized as formula (3), where $x(j)^*$ is the best stable value of $x(j)$.

$$y(i,j)=\frac{x(i,j)-x_{min}(j)}{x_{max}(j)-x_{min}(j)} \quad (1)$$

$$y(i,j)=\frac{x_{max}(j)-x(i,j)}{x_{max}(j)-x_{min}(j)} \quad (2)$$

$$y(i,j)=1-\frac{x(i,j)-x(j)^*}{\max|x(i,j)-x(j)^*|} \quad (3)$$

3.2 Determination of indicator weight In information theory, entropy is a measure of uncertainty. In *A Mathematical Theory of Communication*, Shannon, the American mathematician, founder of the information theory, proposed the information measure based on the model of probability and statistics, he defined the information as the thing for eliminating uncertainty. Based on the measurement function of entropy, taking into account the importance of indicator weight, we adopted the objective weighting method-entropy method to assign weights to the indicators[14-15]. According to the calculation formula, we calculated the weight of each indicator (take the year 2012 for example) w = (0.034 4, 0.031 4, 0.029 4, 0.031 8, 0.072 2, 0.040 4, 0.032 5, 0.010 9, 0.010 2, 0.026 0, 0.012 0, 0.012 7, 0.009 3, 0.108 3, 0.080 7, 0.012 6, 0.010 1, 0.009 1, 0.015 9, 0.080 2, 0.021 9, 0.028 4, 0.052 8, 0.009 3, 0.099 0, 0.063 6, 0.054 7). In the values, the maximum weight was 9.90%, the minimum weight was 0.91%, and the gap between maximum and minimum values was big. We believed that this is reasonable. Indicators with higher weight reflect more information, while indicators with lower weight reflect less information.

3.3 Evaluation of gray relation of New Four Modernizations After establishing the gray relation evaluation model of the development level of New Four Modernizations, we obtained the gray relation. Higher relation indicates closer to optimum indicator value and higher evaluation value of objects to be evaluated. The evaluation results of this study are listed in Table 2.

Table 2 Evaluation results of gray relation of the development level of New Four Modernizations in 2012

City (prefecture)	Gray relation degree	Rank	City (prefecture)	Gray relation degree	Rank
Changsha	0.574 0	1	Zhangjiajie	0.436 4	10
Zhuzhou	0.486 3	4	Yiyang	0.502 2	2
Xiangtan	0.484 0	5	Chenzhou	0.434 5	11
Hengyang	0.490 3	3	Yongzhou	0.458 7	8
Shaoyang	0.442 8	9	Huaihua	0.422 5	13
Yueyang	0.482 1	6	Loudi	0.462 4	7
Changde	0.486 3	4	Xiangxi	0.423 1	12

In order to better study the development level of New Four Modernizations in Hunan Province, using the same method, we calculated the data of 2004 – 2011, and obtained the gray relation coefficient and rank of each city (prefecture). The results are listed in Table 3.

Table 3 Evaluation results of gray relation of the development level of New Four Modernizations in Hunan Province in 2004 – 2011

City	2004		2005		2006		2007		2008		2009		2010		2011	
(prefecture)	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Changsha	0.618 6	1	0.625 3	1	0.552 7	2	0.621 7	1	0.519 0	2	0.625 3	1	0.554 1	2	0.621 7	1
Zhuzhou	0.496 7	5	0.473 3	8	0.532 1	3	0.501 7	4	0.497 3	5	0.516 9	4	0.4969	4	0.482 6	5
Xiangtan	0.497 3	4	0.526 1	2	0.554 4	1	0.503 3	3	0.517 9	4	0.526 1	2	0.5544	1	0.502 6	4
Hengyang	0.518 7	3	0.516 9	3	0.492 2	5	0.569 5	2	0.518 7	3	0.525 9	3	0.4963	5	0.569 5	2
Shaoyang	0.455 7	9	0.460 2	9	0.434 7	9	0.448 2	9	0.465 6	9	0.434 2	12	0.4531	8	0.448 2	9
Yueyang	0.494 0	7	0.498 2	6	0.453 1	7	0.475 3	7	0.495 0	7	0.473 3	7	0.4881	7	0.475 3	7
Changde	0.519 0	2	0.526 1	4	0.488 1	6	0.482 3	6	0.618 6	1	0.477 0	6	0.4922	6	0.481 3	6
Zhangjiajie	0.465 6	8	0.460 2	9	0.434 1	10	0.458 2	8	0.494 0	8	0.460 1	10	0.4347	9	0.458 2	8
Yiyang	0.518 7	3	0.499 8	5	0.496 9	4	0.482 6	5	0.495 2	6	0.499 8	5	0.5321	3	0.503 3	3
Chenzhou	0.442 9	10	0.379 3	11	0.375 9	12	0.394 7	12	0.442 9	13	0.379 3	12	0.3721	13	0.4036	12
Yongzhou	0.448 3	9	0.434 2	11	0.434 1	10	0.446 9	10	0.465 1	10	0.460 2	9	0.4342	10	0.418 2	11
Huaihua	0.495 2	6	0.446 7	10	0.413 1	11	0.418 2	11	0.448 3	12	0.472 0	8	0.419 6	11	0.394 7	13
Loudi	0.465 6	8	0.477 0	7	0.437 2	8	0.403 6	12	0.455 7	11	0.446 7	11	0.413 1	12	0.448 0	10
Xiangxi	0.442 5	11	0.378 3	12	0.372 1	13	0.394 7	13	0.442 3	14	0.377 9	13	0.371 1	14	0.393 7	14

3.4 Comprehensive evaluation of the development of New Four Modernizations of 14 cities (prefectures) in Hunan Province Due to the slight difference of the indicator system in 2004 – 2012, and to make the analysis more concise and clear, we made the comprehensive evaluation of the development of New Four Modernizations of 14 cities (prefectures) of Hunan Province according to their ranks and conducted factor analysis on the basis of changes in ranks. The top three are leading, the last three are backward, and the others are catch-up type. Summarizing Table 2 and Table 3, we obtained Table 4. From Table 4, it can be seen that in 2004 – 2012, Changsha, the capital of Hunan Province, ranked first and had nine times of leading, followed by Hengyang, Xiangtan, Yiyang, Changde and Zhuzhou.

Table 4 Statistics of evaluation results of gray relation of the development of New Four Modernizations in Hunan Province in 2004 – 2012

City (prefecture)	Times of leading	Times of catch-up	Times of backward	City (prefecture)	Times of leading	Times of catch-up	Times of backward
Changsha	9	0	0	Zhangjiajie	0	9	0
Hengyang	7	2	0	Shaoyang	0	7	2
Xiangtan	5	4	0	Yongzhou	0	7	2
Yiyang	4	5	0	Loudi	0	6	3
Changde	2	7	0	Huaihua	0	3	6
Zhuzhou	1	8	0	Chenzhou	0	0	9
Yueyang	0	9	0	Xiangxi	0	0	9

Through the analysis of changes in data of the earliest and latest year (2004 and 2012 respectively), the development types of New Four Modernizations of 14 cities (prefectures) in Hunan Province are shown in Table 5.

Table 5 Types of development of 14 cities (prefectures) in Hunan Province in 2004 and 2012

Type	2004	2012
Leading	Changsha, Changde, Hengyang, and Yiyang (Hengyang and Yiyang tied for third place)	Changsha, Yiyang, and Hengyang
Catch-up	Xiangtan, Zhuzhou, Huaihua, Yueyang, Zhangjiaji, and Loudi	Changde, Xiangtan, Zhuzhou, Yueyang, Loudi, Yongzhou, Shaoyang, and Zhangjiajie
Backward	Xiangxi, Chenzhou, Yongzhou, and Shaoyang (Yongzhou and Shaoyang tied for ninth place)	Huaihua, Xiangxi, and Chenzhou

From the above classification, in 2004 and 2012, Changsha, Hengyang and Yiyang took the leading position all the time; in 2004, Changde took the leading position, but it entered the catch-up position in 2012; in 2004 and 2012, Xiangxi and Chenzhou were backward; in 2004, Yongzhou and Shaoyang were backward, but in 2012, both cities entered the catch-up rank. For Changsha, the score of industrialization, urbanization, informationization and agricultural modernization in 2010 ranked second, first, second,

and first respectively; in 2012, the rank was first, second, first, and first respectively; in 2004 – 2012, the development level of New Four Modernizations ranked the leading position all the time. In the catch-up type, Shaoyang was in the backward position in 2004 and rose to the catch-up position in 2012; its rank of industrialization, urbanization, informatization and agricultural modernization was 9, 6, 6 and 4 respectively; in 2012, the rank was 4, 9, 9 and 9 respectively; in the industrialization, Shaoyang ranked top, which is consistent with the actual situation, but in other three modernizations, Shaoyang ranked lower, showing Shaoyang was always in the catch-up and backward types. Xiangxi was always the backward city, which is basically consistent with the subjective judgment.

4 Conclusions and recommendations

4.1 Bringing into play the long-term mechanism of industrialization and urbanization to agricultural modernization (i) It is recommended to pay close attention to the positive role and value of industrial promotion to agricultural development, to gradually increase the agricultural production technologies and machinery, accelerate the construction of new agricultural economy, attach great importance to reform and innovation of agricultural system, give priority to developing agricultural product processing enterprises, and build agricultural industry clusters meeting demands of modernization. (ii) It is recommended to promote rural economic development with the aid of urban secondary and tertiary industries, constantly strengthen rural infrastructure construction, establish and improve social service functions, and constantly reinforce the promotion of urban economic development to rural economic development. (iii) It is recommended to change the hindrance of industrial development and urban expansion to agricultural development, optimize reasonable allocation of resources, and promote coordinated development of industry, agriculture and service industry. (iv) It is recommended to make reform and innovation of land system. Government should build unified urban and rural construction land system, make effort to create more income for people, establish and improve land requisition compensation policy, to realize institutionalization and standardization of land requisition compensation, and ensure urban and rural construction achievements can be shared by farmers. (v) It is recommended to establish and improve the land contractual management right circulation system, to bring into play the market functions. Government should accelerate the construction of land circulation transaction service platform, establish the land circulation market with the platform as the base, improve the market management system, regulate land circulation behavior, guide farmers to circulate land in compliance with laws, take full advantage of land unavailable for farming, bring into play land value, and advocate agricultural industrialization and cooperatives of land, so as to promote deepening of agricultural system reform, gradually realize agricultural modernization and raise the level of agricultural mechanization. (vi) It is recommended to stress and improve rural basic and vocational education. Farmers are the main force in new socialist countryside construction. The cultural quality, technological capability and ideological and moral standards of farmers directly determine the rise and fall of new socialist countryside construction and determine the success and failure of new socialist countryside construction. It is necessary to further increase capital investment in rural education, provide training of farmers in many aspects[16], provide more training and education opportunities for farmers, constantly raise scientific and cultural qualities and education level of farmers, and raise re-employment ability of farmers.

4.2 Adhering to the coordination of development and promoting the integration of urban and rural development In the period of the 13th Five-Year Plan, Hunan Province should continue to adhere to coordinated development and establish a new pattern of balanced development. Taking Changsha, Zhuzhou, and Xiangtan as the gripper, Hunan Province should push forward regional development of Economic Circle of Dongting Lake, Big Xiangnan and Big Xiangxi, to accelerate the new development pattern of "one core, three poles, four belts, and many points" and explore the urban and rural integrated development mechanism. The bottleneck of the integration of urban and rural areas lies in the management mechanism, the awareness of valuing agriculture but belittling industry formed for a long time still exists. Hunan Province is situated in inland, the old idea is widespread, especially in backward Xiangxi and Xiangnan. As a result, the rural grass-roots government service ability, public service supply capacity, and interest coordination mechanism will lag behind the urban and rural integrated development[17]. One of the fundamental points of simultaneous development of New Four Modernizations is to eliminate the polarization between urban and rural areas and ultimately realize integrated urban and rural development. For this, we must take care of the following points. (i) Making effort to increase income of farmers. In Hunan Province, Luoxiaoshan in Xiangnan and Wuyishan in Xiangxi are two state-level poverty-stricken areas, the task of poverty alleviation is extremely arduous. It is recommended to narrow the income gap between urban and rural residents through increase the income of rural residents. Financial department should increase financial expenditure in rural areas; state policies should support farmers, agriculture, and rural areas, support farmers to start undertaking, promote township enterprises, especially the development of agricultural product processing industry, and attract more idle funds through policy guidance to rural economic development and infrastructure construction. In the period of 12th Five-Year Plan, Hunan Province input 1 540 billion yuan, implemented 59 000 poverty alleviation projects, reduced 5.41 million poor population, increased 3.85 million urban jobs, transferred 3.6 million rural labors, made outstanding achievements, but it still needs increasing input in future. (ii) Stressing the development of non-agricultural industries, especially the processing of agricultural products, and enriching the sources of income of farmers. In fact, the development of non-agricultural industries plays a great role in increasing farmers' income and promoting employment and rural development. In addition, the development of non-agricultural industries will highly manifest the vitality of rural economy, be favorable for expanding domestic demands, promoting the development and progress of rural economy, accordingly accelerating the transformation of rural areas to urbanization. (iii) Promoting balanced allocation of public resources. It is recommended to gradually change the situation

of backward rural education, medical resources, and cultural resources, realize scientific and reasonable allocation of public resources in urban and rural areas, and gradually realize the sharing, reasonable and urban and rural integrated development mode. In addition, it is required to strengthen rural infrastructure construction, raise the modernization level of agricultural development, and realize coverage of education resources and medical resources to rural areas. Only through completely reforming the urban and rural dual development model, may it be able to realize integrated urban and rural development and change the big gap between urban and rural areas Truly, the urban and rural integrated development also can ensure farmers to enjoy achievements of modernization construction, promote modernization of agricultural development, and it conforms to requirements of building a moderately prosperous society in all aspects. (iv) Gradually and orderly promoting the reform of household registration system. In the process of reforming the household registration system, it is required to pay close attention to the interests of migrant workers. In this situation, it is required to safeguard benefits of those rural people who have settled down in urban areas, ensure their treatment the same as urban residents. Besides, it is required to implement relevant rules and regulations, properly treat the problems of education of children, medical care, and housing of migrant workers. Also, it is required to safeguard benefits of migrant workers without urban household registration, constantly raise their social welfare level, and guide them to orderly and harmoniously integrate into urban life, so as to lay a foundation for urban and rural integrated structure.

4.3 Optimizing the modern industrial system and giving impetus to mutual promotion of New Four Modernizations (i) In the period of the 13th Five-Year Plan, Hunan Province should accelerate the construction of a new environment-friendly modern industrial system with strong innovation ability, excellent quality and service, and close cooperation. It is recommended to implement the strategy of building up a powerful nation, fully implement the action plan of *Made in China 2025*, take the improvement of manufacturing innovation ability and basic ability as main points, promote deep integration of information technology and manufacturing technology, promote the development of manufacturing industry in Hunan Province (especially rail transit and heavy machinery) towards high end, intelligent, green, and service, and accelerate cultivation of competitive edge of manufacturing industry of Hunan Province. (ii) It is recommended to continue to support development of strategic new industries of Hunan Province, raise the supporting function of new industries, cultivate and develop strategic industries, and build new pattern of industrial development, to increase the proportion of added value of strategic new industries to 15% of the GDP of Hunan Province. Hunan Province should optimize traditional industries through information technology, to reduce resource costs, increase ecological benefits and ensure pollution-free environment; besides, it should support progress of new information industries based on information technology, such as information services, hardware and software, promote vigorous development of new technologies and new industries, and accelerate the transformation of development power. (iii) It is recommended to promote agricultural modernization of Hunan Province and build the modern agricultural development system. Hunan, as a large agricultural province, must accelerate the process of agricultural modernization through transforming large agricultural province to powerful agricultural province. In the process of promoting the development of agricultural modernization, it is required to integrate with the informationization. It is recommended to improve the development of agricultural modernization and raise the management and operation level of agricultural enterprises using modern information technology.

4.4 Raising the informationization level and promoting balanced regional development Regional development of Hunan Province lies in accelerating the informationization development. Poverty is closely connected with ignorance, while ignorance is largely resulted from backward information. The development of informatization has the following advantages. (i) Breaking the obstacle in regional time and space, promoting upgrade and optimization of industrial distribution in backward regions, reducing the difference of regional development, and gradually narrowing the income gap of urban and rural residents. (ii) Facilitating to promote balanced distribution of public resources, reducing the basic public service differences between different areas, and implementing benefit sharing of the masses. (iii) Facilitating to bring into full play local advantages, highly promote mutual complement, benign interaction, and harmonious development of different areas. Therefore, the key task is to actively promote informationization development, and gradually reduce the gap between urbanization, industrialization and agricultural modernization. In the period of 13th Five-Year Plan period, Hunan Province should further improve its infrastructure, make effort to improve environment, provide conditions for narrowing the regional gap and informationization development, deepen the promotion of Changsha-Zhuzhou-Yingtan City Cluster to Xiangxi, Xiangnan, and Economic Circle of Dongting Lake, take the opportunity of digital Hunan, construction of Xiangjiang new area, and Yangtze River Economic Belt, further accelerate the development, so as to make Hunan become an important engine for rise of central areas.

References

[1] ARTHUR LEWIS. Duality economy theory[M]. Beijing: Capital University of Economics and Business Press, 1998: 16 -27. (in Chinese).

[2] HOFFINANN WALTER G. Stadien typender industrialisterung[M]. Ein Beitragzurquantitaticen Analyse Historischer Wirtschaftsprozesse, 1931: 9 -15.

[3] WALT WHITMAN ROSTOW. The theory of stage of economic growth[M]. Beijing: China Social Sciences Press, 2001: 31 -38. (in Chinese).

[4] HOLLIS B CHENERY. A comparative study of industrialization and economic growth[M]. Shanghai: Shanghai Sanlian Bookstore Press, 1995: 23 -29. (in Chinese).

[5] XU J, GAO HB, WANG YH. Research on the interaction mechanism of new industrialization, informatization, new urbanization and agricultural modernization[J]. Modern Management Science, 2013(9):87. (in Chinese).

[6] XU DW, DUAN SS, LIU CY. The research on the internal mechanism and interactive relationship of the three synchronous development——Based on the theory of collaborative learning and mechanism design[J]. Issues in Agricultural Economy, 2012(2):4 -9. (in Chinese).

(To page 67)

reached a relatively mature stage, and FISH technology has been widely studied in the field of medicine. Research institutions are mainly hospitals or medical research institutes, and affiliated hospitals; periodicals are mainly journals of genetics or medical universities; research objects are mainly obstetrics and gynecology, oncology and cardiovascular diseases, the total proportion is up to 81.35%, researches in crops, pediatrics and other fields are relatively weak. The focus of researches is not balanced. The proportion of crops, biology, horticulture, aquaculture, fishery, and forestry is 6.41%, 6.08%, 4.50%, 1.58% and 1.42% respectively.

(ii) Chromosome FISH technology researches are early in central and southeastern regions of China, and it has made considerable achievements in application of FISH technology in medical field; many master's and doctoral dissertations also research the FISH technology; in terms of the foundation project, about a half foundation project is national natural science function (49.07%), 21.22% are ministerial level foundation projects, 18.57% are provincial level foundation projects, and 11.14% are other foundation projects. From the data, we can see that the FISH technology has obtained great support and received much attention of both the state and levels of government.

References

[1] JOHN HL, BIMSTIEL ML, JONES KW. RNA – DNA hybrids at the cytological level[J]. Nature(London),1969(223): 912 – 913.

[2] RAYBUM AL,PARDUE AL,GILL BS. Use of biontion-labeled probes to map specific DNA sequences on wheat chromosome[J]. Journal of Heredity, 1985(76): 78 – 81.

[3] ZHANG D, HU XM, HU AW. Fluorescence *in situ* hybridization and its application in genetics[J]. Applied Journal of General Practice, 2010,8(6):762 – 764. (in Chinese).

[4] LU J, ZHANG J, HE YS. Fluorescence *in situ* hybridization and clinical applications[J]. Journal of Molecular Diagnosis and Therapy, 2009, 1(1): 38 – 42. (in Chinese).

[5] AMANN R, KRUMHOLZ L, STAHL DA. Fluorescent-oligonucleotide probing of whole cells for deteminative,phylogenetic,and environmental studies in microbiology[J]. Journal of Bacteriology,1990,172:762 – 770.

[6] GIOVANNONI SJ, DELONG EF, OLSEN GJ, *et al.* Phylogenetic group specific oligodeocy nucleotide probes for identificationof single microbial mells[J]. Bacteriol, 1988,128(170):720 – 726.

[7] STREPHEN J, GIOVANNONI E, DELONG F, *et al.* Phylogenetic group-specific oligodeoxynucleotide probes for identification of single microbial cell[J]. Bacteriol,1988,170(2): 720 – 727.

[8] WEI WH, ZHAO WP, WANG LJ, *et al.* Karyotyping of Brassica napus L. based on C0t-1 DNA banding by fluorescence *in situ* hybridization[J]. Chinese Bulletin of Botany, 2005, 47(12): 1479 – 1484. (in Chinese).

[9] ZHOU SJ. Detection of Alstroemeria aurea chromosomes in a series of its hybrid[J]. Acta Horticulturae Sinica,2002,19(3): 255 – 257. (in Chinese).

[10] ZHOU SJ. Discrimination of the genomes in BC1 progeny of asiatic lily and oriental lily using GISH[J]. Acta Horticulturae Sinica, 2003, 30(4): 485 – 486. (in Chinese).

[11] CLARKM, *et al.* Physical mapping of B-hrdeinloci on barley chromosome 5 by *in situ* hybridization[J]. Gempme,1989,32:925 – 929.

[12] CHENG Z, PRESTING GG, BUELL CR, *et al.* High resolution pachytene chromosom emapping of bacterial artificial chromosomes anchored by genetic marker sreveals the centromere location and the distribution of genetic recombination along chromosome 10 of rice[J]. Genetics, 2001,157:1749 – 1757.

[13] DONG QL, YUAN ST, LIANG S, *et al.* Analysis of wetland literatures based on Web of Science[J]. Journal of Anhui Agricultural Sciences, 2010, 38(8): 4386 – 4388. (in Chinese).

(From page 16)

[7] WU YY. Thinking on the establishment of new industrialization evaluation index system[J]. Statistics and Consultation, 2003(2):16 – 17. (in Chinese).

[8] CHEN SL, TANG J, WU CC. The design of the statistical indicator system for the new-type industrialization[J]. Journal of Guizhou College of Finance and Economics, 2004(3): 10 – 13. (in Chinese).

[9] SHI R, ZHOU NY. Cluster analysis of regional information development based on factor analysis[J]. Journal of Yunnan Agricultural University (Social Science), 2011, 5(2): 66 – 70. (in Chinese).

[10] SHEN Q, HU ZJ. New ideas for improving the index system of agricultural modernization in China[J]. Statistics and Decision, 2012(15):38 – 42. (in Chinese).

[11] ZHANG MD. The endogenous study of urbanization level and economic growth[J]. Macroeconomics, 2013(10): 87 – 94. (in Chinese).

[12] YUAN XL, JING XJ, YANG WP, *et al.* The interaction mechanism of "new four modernizations" and its development level measure[J]. Urban Problems, 2013(11): 54 – 60. (in Chinese).

[13] SHAO Y. Reshaping China: new urbanization, deep urbanization and new urbanization[J]. Financial Development Review, 2013(1):1 – 37. (in Chinese).

[14] HUANG AS, XU JX. Evaluation and study on the development level of industrialization, informatization, urbanization and agricultural modernization[J]. Journal of Fuzhou University(Philosophy and Social Sciences), 2013, 27(6): 28 – 33. (in Chinese).

[15] JIANG YX. "The four modernizations simultaneous development" SD model system design and research in the new urbanization background [J]. Journal of Fujian School of Administration and Fujian Institute of Economics and Management, 2016(3): 93 – 102. (in Chinese).

[16] MA DJ, XIN X. Coupling characteristics of urbanization and agricultural modernization: An analysis of the western region of China[J]. Reform, 2016(5): 57 – 66. (in Chinese).

[17] RUAN JG. Research on the dynamic evaluation of the "four-modernizations" synchronous development level——Based on all-around principal component analysis[J]. Journal of Southwest Jiaotong Universit(Social Science Edition),2016, 17(3):51 – 57. (in Chinese).

[18] HUANG XF, CHEN JC, ZHOU W. Measure on the the "four modernizations" coupling coordinated development leve in 11 cities of Jiangxi Province[J]. Urban Problems, 2015(3):67 – 73. (in Chinese).

[19] FANG H. The coordination empirical study of industrialization, urbanization, agricultural modernization, informationization development for Guangdong Province[D]. Guangdong: Jinan University, 2014(5): 5 – 6. (in Chinese).

[20] ZHANG YB. Research on "four modernizations" harmonious development in Guangxi[D]. Guangxi: Guangxi University, 2015(6): 6 – 57. (in Chinese).

[21] XIAO YX. Research on agricultural modernization, urbanization, industrialization and informatization in Heilongjiang reclamation area[D]. Daqing: Heilongjiang Bayi Agricultural University, 2015(6):47 – 64. (in Chinese).

[22] GUO XG. Application of improved entropy method in evaluation of economic result[J]. Systems Engineering—Theory & Practice,1998, 18(12):99 – 103. (in Chinese).

[23] LIU SF, GUO TB, DANG YG, *et al.* Grey system theory and its application[M]. Beijing: Science Press, 2000: 78 – 82. (in Chinese).

[24] YANG NM. Production and development, rural civilization and the construction of new countryside——Based on the two-brand experience of Hunan[J]. Industrial & Science Tribune, 2016, 15(1): 98 – 100. (in Chinese).

[25] YANG NM. Urban and rural balanced development evaluation in Hunan Province[J]. Economic Geography, 2014, 34(3): 58 – 64. (in Chinese).