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Regional Sustainable Development of Rural Areas Based on HDI—A Case of Jilin Province, China

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Abstract This paper introduces the connotation of Human Development Index (HDI) and its dimensional indices, as well as the HDI comprehensive evaluation method based on entropy weight. And the specific formula and steps for calculation are put forward. This paper also selects the HDI dimensional indices (life expectancy index, education index and GDP index), and constructs the evaluation index system of regional sustainable development. Based on the field investigation on Yushu, Jiutai and Yongji in Jilin Province, relevant data of HDI dimensional indices are collected. According to the comprehensive evaluation method based on entropy weight, sustainable development levels of the three typical rural areas in Jilin Province are evaluated. Result shows that the descending order of the sustainable development status of rural areas is Yongji, Jiutai and Yushu, indicating that the sustainable development levels are relatively backward. Educational levels of the three areas (counties) have a relatively large gap; and the quality of secondary education in rural areas remains to be improved. Ageing of population is growing in Jilin Province, and life expectancy of the three areas (counties) rises sharply. There are small differences among the national economic development of the three areas (counties) with the descending order of per capita GDP index being Yongji, Yushu and Jiutai. Based on this, relevant policy recommendations are put forward. Firstly, improve the continued investment in basic and secondary education in rural areas with practical measures. Secondly, strengthen the rural health care and welfare protection in rural areas in order to improve the living standard of rural residents. Thirdly, while maintaining rapid economic growth, we should pay attention to the population factors and strive to the steady growth of per capita economic level.

Key words Human development index (HDI); Rural area; Sustainable development; Entropy weight; China

Regional economy plays an increasingly important role in the economic development of a country; and sustainable development, a new development concept and model, has been gradually accepted by countries all over the world. Sustainable development refers to a kind of development aiming to meet the needs and aspirations of the people without sacrificing the interests of future generations. Region, a complex system, includes not only the development situation of economy, environment and society, but also the interaction of human, economy, environment, resource and system. Regional sustainable development is a comprehensive concept involving economic growth, resources and environment, society and so on. Evaluation on regional sustainable development is an important research direction of the application of sustainable development theory. The key to evaluate the level of regional sustainable development is to select appropriate index system and assessment method. Thus, evaluation index system of regional sustainable development should be comprehensive, but not all-inclusive.

Based on the field investigation on Yushu, Jiutai and Yongji in Jilin Province, we collect the relevant data of HDI dimensional indices, and use the comprehensive evaluation method based on entropy weight to evaluate the sustainable development of the three typical rural areas in Jilin Province, so as to provide references for decision making of related policies.

1 HDI comprehensive evaluation method based on entropy weight

Construction of sustainable development evaluation index is generally based on ecology, economics, sociology and systematics. One of the most representative indices in the world is the Human Development Index (HDI) developed by the United Nations Development Programme (UNDP) at the year 1990^[1]. After more than ten years' practice and improvement, HDI has been widely used to measure and compare the relative levels of human development among countries and regions due to its succinct and clear natures. And HDI has become a suitable tool for the evaluation of regional sustainable development. Three dimensions of HDI composite index representative the three basic choices of human, which are the longevity and a healthy life, the knowledge acquirement, and the resources for a decent life. Longevity index is measured directly by the life expectancy at birth, having a high correlation with health, nutrition and other conditions. Longevity reflects people's health, nutrition and other variables. Knowledge is marked by the realization degree of education with the substitution indices of the literacy rate of adults and the comprehensive enrollment rate of primary, secondary and higher education. And resources acquirement is calculated by the per capita GDP of the adjustment of purchasing power parity.

HDI measures the relative development level of regions, and can be used to compare the development gap between different regions. UNDP adopts the method of simple arithmetic average for weight distribution of the HDI dimensional indices with its own limitations. Compared with evaluation purposes, importance of the three dimensional indices of HDI varies at dif-

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ferent periods, so that we should not simply or subjectively give equal weight to all the indices. Wang Xiaoyan and Chen Liming have conducted comprehensive evaluation by the method of weighting entropy^[2].

1.1 Establishment of evaluation matrix It is assumed that there are n evaluation objects (areas), which are denoted by Y_1, Y_2, \dots, Y_n ; the m evaluation dimensional indices are labeled as X_1, X_2, \dots, X_m ; and evaluation matrix A is constituted by the values of evaluation objects under different dimensional indices:

$$A = \begin{matrix} X_1 \\ X_2 \\ \vdots \\ X_m \end{matrix} \begin{pmatrix} Y_1 & Y_2 & \cdots & Y_n \\ a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{pmatrix} \quad (1)$$

where a_{ij} , a profitability index, is the value of the j th evaluation object under the i th dimensional index. After standardization of matrix A , we have

$$R = (r_{ij})_{m \times n}, \quad (2)$$

where $r_{ij} = \frac{a_{ij} - \min_j \{a_{ij}\}}{\max_j \{a_{ij}\} - \min_j \{a_{ij}\}}$, $r_{ij} \in [0, 1]$.

1.2 Calculation of index entropy In the evaluation on m dimensional indices and n evaluation objects, the fuzzy entropy of the i th dimensional index is^[3]:

$$H_i = -k \sum_{j=1}^n [r_{ij} \ln r_{ij} + (1 - r_{ij}) \ln (1 - r_{ij})] \quad (3)$$

where $i=1, 2, \dots, m$; $k=1/(n \ln 2)$ is a constant, satisfying $0 \leq H_i \leq 1$. If $r_{ij}=0$, let $r_{ij} \ln r_{ij}=0$.

Table 1 HDI index and its threshold

Dimensional index	Index	Maximum	Minimum
Life expectancy index	Life expectancy at birth//years	85	25
Education index	Literacy rate of adult//%	100	0
	Comprehensive gross enrollment rate//%	100	0
GDP index	Per capita GDP //PPP U. S. Dollars	40 000	100

Note: Weight of adult's literacy rate is 2/3; and weight of comprehensive gross enrollment rate is 1/3.

2.2 Calculation result Table 2 reports the calculation result of $EWHDl$ of Yushu, Jiutai and Yongji in Jilin Province, as well as their dimensional indices, by using entropy weight comprehensive evaluation method.

2.3 Result analysis Table 2 indicates that the degrees of regional sustainable development of the three areas (counties) are relatively close with the descending order of Yongji (0.645 4), Jiutai (0.594 8) and Yushu (0.569 3). These data are significantly lower than the national average according to reference [5], indicating that the regional sustainable development level of rural areas in Jilin Province is relatively backward.

Table 2 Evaluation index data of typical rural area in Jilin Province in the year 2006

Dimension index	Entropy weight	Yushu	Yongji	Jiutai
Life expectancy index	0.312 6	0.829 9	0.850 0	0.783 3
Education index	0.390 1	0.548 5	0.689 6	0.680 0
GDP index	0.297 2	0.322 7	0.372 3	0.284 6
$EWHDl$		0.569 3	0.645 4	0.594 8

1.3 Calculation of entropy weight Smaller entropy weight in equation (3) indicates that the information in corresponding evaluation criteria is more effective. Hence, entropy weight ω_i of the i th evaluation criteria becomes $\omega_i = (1 - H_i) / (m - \sum_{i=1}^m H_i)$, where $i=1, 2, \dots, m$.

1.4 Comprehensive evaluation of entropy weight Comprehensive evaluation index of the j th evaluation object is denoted by $EWHDl_j$, with the calculation formula of $EWHDl_j = \sum_{i=1}^m \omega_i a_{ij}$, where $j=1, 2, \dots, n$, a_{ij} is the value of the j th evaluation object under the i th dimensional index.

2 Empirical analysis on the typical rural areas in Jilin Province

2.1 Data sources and arrangement Rural area in the empirical analysis is confined to the scope of county. According to the connotation of HDI and relevant data, after investigating the *Statistical Yearbook of Jilin Province* and other relevant literature data, we conduct field survey on Yushu, Jiutai and Yongji in Jilin Province, and collect the relevant original data of indices "life expectancy", "literacy rate of adult" and "comprehensive gross enrollment rate". Per capita GDP index of three areas (counties) in the year 2006 is obtained through consulting to related statistical yearbooks. Calculation of dimensional indices data adopts the threshold limitation of HDI dimensional indices by the UNDP, which is shown in Table 1^[4].

2.3.1 Education degree. Table 2 also indicates that among the index data of the three areas (counties) in Jilin Province, entropy weight of education index is 0.390 1, which is bigger the other two indices. This means that there is relatively large gap among education levels in the three areas (counties). Therefore, dimensional index of education can better reflect the differences of regional sustainable development among the three areas (counties) than the other two dimensional indices. As for the rural areas in Jilin Province, this means that education degree of rural residents plays a relatively important role in regional sustainable development. Thus, based on strengthening the education reform, effective implementation of relevant educational policies should be emphasized in China.

Education index is composed of the literacy rate of adult and the comprehensive gross enrollment rate at different education levels. The three areas (counties) have high literacy rate of adult, but low comprehensive gross enrollment rate at different education levels, which accords with the corresponding index data in the 2005 *China Human Development Report*^[6]. In particular, enrollment rates of primary school and

secondary school are very high, reaching more than 95%, or even 100%, which is caused by the implementation of nine-year compulsory education. But enrollment rates of high school and university are still extremely low, showing that secondary education in rural areas of Jilin Province still remains to be improved.

There are many villages in poverty in Jilin Province, where the youth becomes the main labor force of agriculture, or works outside the home in order to maintain their livelihood. Economic backwardness in rural areas leads to a relatively low enrollment rate of high school and university, which also reflects that the pure pursuit of GDP growth can not represent the overall situation of economic and social development of a given region.

2.3.2 Life expectancy. Life expectancy at birth is a very comprehensive index, affected by a variety of factors, mainly including income level, development of medical and health services, and education level. Among them, income level affects the affordability of sick people; development of medical and health services, especially the changes in the layout of medical and health institutions, determines the service quality and convenient degree for sick people; and education degree influences the basic knowledge about medical and health services acquired by the people, as well as the cooperative ability of disease prevention and treatment^[6]. With the increasing income of residents, the input in education and the medical and health services by the government, life expectancy in the three areas (counties) have improved markedly.

In a way, ageing of population is growing in Jilin Province. According to the predictions of Jilin University, proportion of elderly population aged 65 and over will exceed 7% in the year 2010, and 10% in the year 2020. And ageing process of population will gradually speed up^[7].

2.3.3 GDP index. As is shown in Table 2, entropy weight of GDP index is the lowest (0.297 2), indicating that there are little differences in the national economic development among the three areas (counties). Therefore, weight of GDP index is relatively low in the evaluation of regional sustainable development. This is determined by the nature of entropy weight, and reflects the rationality of entropy weight. It can be concluded that if authorities in this region only pursue for economic growth and neglect the indices of education and life expectancy, evaluation result will show a relatively low status of sustainable development. In other words, the sustainable development will not be realized, which is consistent with the common sense.

Table 2 shows that the descending order of per capita GDP index is Yongji, Yushu and Jiutai, which is different from the order of total GDP. The order of total GDP in the year 2006 is Yushu (111 478.5 billion yuan), Yongji (287.4 billion yuan) and Jiutai (7.897 billion yuan). Inconsistency of order of the three areas (counties) is caused by many factors including the total population, and the uneven regional economic development in Jilin Province. During the economic development and the improvement of total GDP, local government should not ignore the per capita GDP index, which is the only way to achieve real improvement of people's living standard.

3 Conclusion

The comprehensive, coordinated and sustainable scientific development concept requires us to change the focus of attention from GDP to human-centered overall development of environment, economy and society. Therefore, comprehensive evaluation based on HDI provides important references for decision-makers of relevant policies. On the basis of the above empirical analysis, it is pointed out that local government should pay special attention to several issues when making policy measures to promote the rural regional sustainable development. Firstly, improve the continued investment in basic and secondary education in rural areas with practical measures. Secondly, strengthen the rural health care and welfare protection in rural areas in order to improve the living standard of rural residents. Thirdly, while maintaining rapid economic growth, we should pay attention to the population factors and strive to the steady growth of per capita economic level.

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西部地区农业信息资源集成整合研究

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摘要 概述了中国西部地区农业信息资源集成整合的实质与意义。从农业信息基础设施、数据库、协同管理、服务应用 4 方面介绍了西部地区农业信息资源集成整合的方法。农业信息基础设施的集成整合应统筹该地区的网络环境和不同系统、不同部门建成的信息场所与设施, 实现资源与网络设施的对接; 通过标准化处理, 将不同类型信息资源组织为相同的数据格式, 建立统一标准的若干个数据库, 将离散的信息资源重组与关联, 构成完整的数据库群; 建立跨系统、跨部门的农业数字信息资源共建、共享联合体, 各方可协同进行数据的二次开发、分析和决策; 应建立专业的行业信息搜索引擎, 为用户提供个性化的服务。探讨了农业信息资源的集成整合技术, 其技术核心在于: 通过软件手段解决分布式应用的集成, 通过消息控制完成跨部门、跨系统的信息交换与共享。在介绍了几种常用信息终端的基础上, 分析了西部地区实现农业信息资源传播的途径。提出了实现西部地区农业信息资源集成整合的措施: 建立西部农业信息资源共享联盟, 实现管理联合、资源共享; 丰富农业信息资源, 提高信息质量, 建设资源中心, 创新开发技术; 构建基于环境、网络和密码安全 3 个层面的信息安全管理体。

关键词 西部地区; 农业信息资源; 集成整合

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基于 HDI 的农村区域可持续发展评价——以吉林省为例

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摘要 理清了人类发展指数(HDI)及其 3 个维度指标的内涵, 介绍了基于熵权的 HDI 综合评价方法, 给出了具体计算公式和步骤。选取 HDI 维度指标, 即预期寿命指数、教育指数、GDP 指数, 构建了区域可持续发展的评价指标体系。在实地调查中国吉林省榆树、九台、永吉 3 个区(县)的基础上, 收集、整理了 HDI 维度指标所需的相关数据。运用基于熵权的综合评价方法, 对吉林省 3 个典型农村区域的可持续发展水平进行了评价。结果表明: 3 个地区的农村区域可持续发展状况按降序排列依次为永吉、九台、榆树, 其可持续发展水平相对落后; 3 个区(县)在教育水平方面的差距较大, 农村区域的中等教育质量有待提高; 吉林省人口老龄化程度在不断加剧, 3 个区(县)的人口预期寿命有明显提高; 3 地在国民经济发展方面的差距不大, 人均 GDP 指数的降序排列依次为永吉、榆树、九台。在此基础上, 提出了相关政策性建议: 一是重视、提高并有切实的措施保证对农村地区基础和中等教育的持续投入; 二是加强农村医疗和农民福利等方面的保障, 以提高乡村居民的健康生活水平; 三是在保持经济高速增长的同时, 关注人口因素, 力求人均经济水平的平稳增长。

关键词 人类发展指数(HDI); 农村区域; 可持续发展; 熵权