

Dynamic Analysis of Coupling Relationship between Economic Development and Ecological Environment of Hubei Province

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Abstract

Since the reform and opening, the economic development of Hubei province and city construction has made remarkable achievements, at the same time, the contradiction between the ecological environment and economic development is increasingly prominent. In this paper, from two aspects of economic growth and ecological environment, we select the appropriate indicators from 2000 to 2010, using the improved entropy method and we calculate the coupling coordination degree between economic development and ecological environment. From the results, we can see the evaluation indices of economic development, ecological environment and coupling coordination degree are increasing, indicating the overall harmonious development of economy and environment is enhanced, but it is still in the medium imbalance at present. We need to reduce the pressure on the environment, developing circular economy, promote the sustainable development of the society in the future.

Keywords: economic development, the ecological environment, the entropy method, coupling coordination degree

1. Introduction

In today's rapid economic growth, the problem of environmental degradation and resource depletion attracts more and more attention to the human. The coordinated development is very important to ensure realize sustainable development of human society. Many experts and scholars research on this problem by EKC (Environmental Kuznets Curve) model, principal component analysis, regression analysis, analytic hierarchy process, fuzzy mathematics, SD(system dynamic) model etc. For the problem of sustainable development index system, assignment of index weight is one of the important content. The methods to identify the index weight are subjective value assignment and objective value assignment. The former is the method to determine weight according to the degree of attention by evaluators; the latter is to determine the index weight according to the contact strength and amount of information provided by objective original data, such as the entropy value method, factor analysis and multiple correlation coefficient method, etc.

Since China's reform and opening up, economic development of Hubei province has made remarkable achievements, at the same time, the contradiction between ecological environment and economic development becomes increasingly prominent. Industrial pollution is the main source of environmental pollution in Hubei province. In this paper, from two aspects of economic growth and ecological environment, from two aspects of economic growth and ecological environment, we select the appropriate indicators from 2000 to 2010, using the improved entropy method and we calculate the coupling coordination degree between economic development and ecological environment.

2. Entropy Method

2.1 Basic Principles of Entropy Value Method

We get formation matrix $(x_{ij})_{n \times m}$ through the original data, n is the number of index, m is the number of year. For an index x_j , if the gap of x_{ij} is greater, the index in the comprehensive evaluation is more important; the less the vice. If values of an index are equal, then this index is ineffective in the comprehensive evaluation. In information theory, there is a function relationship: $H(x) = -\sum_{i=1}^n p(x_i) \ln p(x_i)$. The left $H(x)$ is information entropy, which is the disorder of the metric system; the right is information, which is the orderly degree of measurement system. For an index, the degree of discrete is greater, $H(x)$ is less, then the amount of information provided by the indicator is greater and the weight is also greater; On the other hand, the degree of discrete is smaller, $H(x)$ is greater, the amount of information provided by the indicator is smaller and the weight is also smaller. So we can use information entropy to determine the index weight according to the discrete degree among indicators, which will serve as a scientific basis for the ability of regional sustainable development evaluation.

2.2 Basic Steps of Entropy Method

(i) Index quantification: we calculate proportion p_{ij} of the j th index on the i th year.

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^m x_{ij}} \quad (1)$$

(ii) We calculate entropy value e_j of the j th index:

$$e_j = -k \sum_{i=1}^m p_{ij} \ln p_{ij} \quad (2)$$

$k > 0$, Normally we have $k = 1/\ln m$, then $e_j = -(1/\ln m) \sum_{i=1}^m p_{ij} \ln p_{ij}$, $0 \leq e_j \leq 1$

(iii) We calculate coefficient of variation g_j of the j th index. If entropy value is smaller, the difference is greater, and this index is more important.

$$g_j = 1 - e_j \quad (3)$$

(iv) The weight of the j th index a_j :

$$a_j = g_j / \sum_{j=1}^n g_j \quad (4)$$

(v) Comprehensive evaluation value of the i th year

$$f_i = \sum_{j=1}^n a_j p_{ij} \quad (5)$$

2.3 Improved Entropy Method

Because of using the logarithmic and entropy concept in the entropy value method, due to the negative can't directly involve in the calculation, we need to change this kind of index data certainly. According to the research, the entropy value method is more reasonable by standardized methods of data processing.

We use the following formula to standardize the index data:

$$x'_{ij} = (x_{ij} - x_j) / s_j \quad (6)$$

There x'_{ij} is the standardization of parameter values, x_j is meant for the j th indicator, s_j is standard deviation for the j th indicator.

Using the following type to eliminate the negative effects by coordinate translation:

$$z_{ij} = A + x'_{ij} \quad (7)$$

z_{ij} is the values after translation, A is translational amplitude, then we use z_{ij} as x_{ij} to do data analysis through(i)-(v).

2.4 Introduction of the Coupling Degree Model

Let C and T be respectively coordinative degree and comprehensive evaluation index of economic and ecological environment. They can reflect the synchronization the economic development and ecological environment evolution, and overall efficiency of economic development and the regional ecological environment, then we have

$$C = 2 \left[\frac{XY}{(X+Y)^2} \right]^{\frac{1}{2}} \text{ and } T = \alpha X + \beta Y,$$

There X and Y are respectively comprehensive development index of economic development and ecological environment. α and β are pending weight. Normally we let $\alpha = \beta = 0.5$. Then we form the coupling degree model of economic development and ecological environment evolution:

$$D = \sqrt{CT}$$

Then we can divide the coupling development of the regional economy development and the ecological economic into 10 grades:

Extreme imbalance ($0 \leq D < 0.1$); Serious imbalance ($0.1 \leq D < 0.2$);

Moderate imbalance ($0.2 \leq D < 0.3$); Mild imbalance ($0.3 \leq D < 0.4$);

Endangered imbalance ($0.4 \leq D < 0.5$); Reluctant coordination ($0.5 \leq D < 0.6$); Primary coordination ($0.6 \leq D < 0.7$); Intermediate coordination ($0.7 \leq D < 0.8$); Good coordination ($0.8 \leq D < 0.9$);

Quality coordination ($0.9 \leq D < 1.0$).

3. Choice of Evaluation Index

We select the following economic development and ecological environment indicators from 2000 to 2010 of Hubei Province, which are from the "Statistical Yearbook of Hubei province". For economic development indicators: the overall GDP, per capita GDP, total fixed asset investment, the proportion of the second industry and the third industry proportion.

For the ecological environment: the total amount of pollution of waste water discharge, industrial waste gas emission, industrial solid waste emissions, industrial waste water discharge standards, the comprehensive utilization rate of industrial solid waste, comprehensive utilization of three waste.

4 Empirical Analyses

We analyze the evaluation index of the economic development and ecological environment of Hubei province according to the improved entropy method, and we get the coupling degree model of economic development and ecological environment (Table 1).

Table 1: Coordinated Development Characteristics of Economic and Environmental in Hubei Province (2000-2010)

Year	Economic index	Ecological environment index	C	T	D	The type of coordinated development
2000	0.026121	0.027706	0.999567	0.026914	0.164018	Serious imbalance
2001	0.029487	0.02676	0.998824	0.028123	0.167602	Serious imbalance
2002	0.032786	0.037924	0.997357	0.035355	0.187782	Serious imbalance
2003	0.032636	0.040558	0.994126	0.036597	0.19074	Serious imbalance
2004	0.02991	0.046809	0.975438	0.03836	0.193436	Serious imbalance
2005	0.032709	0.045161	0.987131	0.038935	0.196045	Serious imbalance
2006	0.037415	0.049708	0.989996	0.043561	0.207667	Mild imbalance
2007	0.041044	0.053507	0.991275	0.047275	0.216479	Mild imbalance
2008	0.041092	0.060462	0.981642	0.050777	0.22326	Mild imbalance
2009	0.048238	0.060645	0.993487	0.054442	0.232566	Mild imbalance
2010	0.051561	0.07776	0.979264	0.064661	0.251635	Mild imbalance

It can be seen from table 1, since 2000, economic development and ecological environment of Hubei province has got fast development. The rising advance of coupling coordination degree D from 2000 to 2005 is relatively slow. After 2005, both the economy and environment have grown steadily. The coupling coordination degree of economic and ecological environment has increased from 0.164 to 0.196, but the economic development lags behind during this period, the level of economic evaluation value only increased from 0.026 to 0.033, especially economic growth has slipped in 2003 and 2004, which because of the influence of national SARS disease. During this period, the coupling degree of the economy and the environment is between 0.1 and 0.2, which belongs to the serious imbalance state, This suggests that the coupling relationship of economy and environment is relatively weak, the government only attach great importance to economic development and ignore the environment problem. The mode of production is mainly is high input, low output. From 2006 to 2010, the coupling coordination degree increased from 0.207 to 0.252, this is between 0.2 and 0.3, belonging to moderate disorder. This indicates that the problems of economic and environment have been alleviated, but it is still serious.

According to dynamic analysis of the coupling coordination degree of economic development and ecological environment in nearly 10 years, it is an overall upward trend, but the differences of coordinated development between each subsystem are very obvious, and the current development pattern also exists weak links. To achieve coordinated development of economy and environment of Hubei province, we must adhere to do the following work:

- (1) The government should speed up the ecological environment construction, strengthen the environmental protection. In contempt of ecological environment in the construction of the current economic situation is common, it should strictly control each unit pollutant emissions in accordance with the relevant laws and regulations, and the government should give punishment for excessive amounts of units, and deal with the pollutants depends on the ability of the unit.
- (2) The government should speed up the adjustment of industrial structure, developing ecological economics, widely use new equipment, new technology, new technology and new materials in the production process, and develop good or harmless industry, then finally form economy growth mode of input, low consumption, low emissions and high efficiency.

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