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Analysis of economy, environment pollution coupling structure and industrial structure in China

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ABSTRACT

Because the industrial processing extracts materials from natural resources and abandoned emissions back to nature, the regional economic influence form the coupling relationship with system and environment system. Coupling coordination degree model is used in this paper to establish evaluation system, taking the actual area of the economic environment after the coupling of data into system and analyzing the spatial pattern of industrial structure in China. Relevant conclusions are drawn to provide the basis for the future department policy related.

Coupling refers to the collaborative phenomenon that two or more systems or exercise through interacts and mutual influence between each other. Coupling term originally is derived from physics. From the perspective of synergetics, the key to make the system from disorder to order system is system synergy between internal order parameter; it drives system, the characteristics and law of phase transition. The coupling is the measure of this synergy. Coupling analysis can be divided into two steps: first, to evaluate the state of each subsystem; second, the calculation and evaluation of coupling.

How to realize the regional sustainable development between economic system and ecological environment system is always a focus of economics at home and abroad. Within the past century global economy demand rapid growth, from a global perspective on these issues research increase gradually, even involves the economic impact on Antarctica. Since China's reform and opening up, China's rapid economic growth, but also led to the decrease of the quality of the environment at the same time, frequent occurrence of environmental pollution. Parts in order to priority to the development of the economy, there is no ecological environment problems caused by economic development may make reasonable forecast evaluation, leading to a series of environmental problems, the result will hinder economic industry health and sustainable development. Because of China's regional economic structure gradually towards the metropolis group of industrial agglomeration area and population as the core of diversified structure, economy and environment of the coupling coordination also gradually show the pattern of complicated and varied. The spatial pattern characteristics are cannot be reflected by the provincial level analysis. To detailed analysis of China's regional economic development and environmental pollution spatial pattern characteristics of coupling, coupling in this paper, through the establishment of China's regional unit economic environment evaluation index system, to the economic development of China's 31 provincial units and coupling of environmental pollution and the coordination degree of spatial pattern and difference analysis, and from the Angle of industry structure and the types of the spatial pattern of structure analysis.

KEYWORDS

Economic development; Environmental pollution; Coupling coordination; Spatial analysis; Industry structure; China.
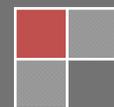
RESEARCH METHOD AND INDEX SELECTION

Research methods

First of all, the data is standardized processed. Regional economy and the ecological environment system is mainly composed of economic system and ecological environment system, each system is made up of a number of indicators, considering the dimension is not unified, the index needs standardize data processing[1]. Set x_{ij} as the index in the system, when the x_{ij} bigger, the better the system function is the numerical size of contribution to the effect of system for timing, referred to as positive indicator; When the smaller x_{ij} value shows that the system function better, the numerical size of contribution to the effect of system is negative, called the negative index. y_{ij} as standardized data, reflect the satisfaction of a goal, $0 \leq y_{ij} < 1$ and when $y_{ij} = 0$, for the most not satisfied; And when the $y_{ij} = 1$, for the most satisfaction. Standardized formula as shown in formula 1-1 is as follows:

Positive index: $y_{ij} = \dfrac{(x_{ij} - x_{ij\,min})}{(x_{ij\,max} - x_{ij\,min})}$ (1)

Negative index: $y_{ij} = \dfrac{(x_{ij\,max} - x_{ij})}{(x_{ij\,max} - x_{ij\,min})}$ (2)

Second is the principal component analysis. In order to effectively achieve dimension reduction, the collected data of the regional system and the ecological environment system using principal component analysis method, to extract can reflect the characteristics of the overall data of the common factor, further calculation of 31 regions in common factor score, as further coupled coordination analysis of data. System comprehensive score computation formula is as follows:

$$F_n = \sum_{j=1}^{m} P_j Z_{mj}$$ (3)

At last, the coupling coordination model[2]. Using coupling model in physics, on the basis of related research, this study put forward the economic system and ecological environment system of coupling coordination calculation formula:

$$C = \left[\frac{f(x)g(x)}{[\alpha f(x) + \beta g(x)]^2} \right]^k$$ (4)

$$P = \alpha f(x) + \beta g(x)$$ (5)

$$R = (C \times P)^{1/2}$$ (6)

In the above formula: f (x) and g (x) are respectively the comprehensive evaluation index of regional economic system and ecological environment, gotten on the basis of the principal component analysis. C for coupling; R to coordination degree; α and β as of undetermined coefficients, this study thinks that the economic system is the same as the importance of ecological environment system, so take $\alpha = \beta = 0.5$; as the adjustment coefficient k, this research take k = 2[3]. Apparently C ∈ [0, 1], when the C = 1, economic system and ecological environment system in the optimal coupling state; When C = 0, show that between all the elements within the system in the independent state, the system will develop to the disorder. Same R ∈ [0, 1], according to the size of the numerical phase coupling coordination level can be divided (TABLE 1).

TABLE 1 :The coupling coordination degree of hierarchy

Coupling Degree C	0-0.3	0.3-0.5	0.5-0.8	0.8-1.0
Coupling level	Low stage coupling	Antagonism	Running-in stage	High level coupling phase
Coordination degree R	0-0.3	0.3-0.5	0.5-0.8	0.8-1.0
Coupling coordination level	Low coupling coordination	Low coupling coordination	High coupling coordination	Low-grade coordination coupling

Index selection

    Economic system and ecological environment system is a complex concept, on the basis of the related research results, based on the authenticity of the data at the same time, availability, comparability, this study will be the economic system is decomposed into economic power, development potential and dynamic architectural systems, a total of select eight indicators represent the development of regional economic system[4]. If the human body, the ecological environment is the human survival and development of natural factors affecting the synthesis, mainly including the other environmental elements other than the person, such as water, soil, air, and other biological resources and energy. Human development will inevitably cause certain destruction to the ecological environment, human has certain subjective initiative at the same time, to take some remedial measures of ecological destruction, therefore this study will be divided into the ecological environment system is mainly the environment pollution and environmental governance 2 architectural system six indicators, the index system are shown in TABLE 2.

TABLE 2 : Region economy and the environment subsystem comprehensive evaluation index system

System	Function	Indicator
economic comprehensive evaluation	Regional economic strength	Per capita GDP
		Industrial output region
		Revenue per capita
	Regional development potential	The whole society fixed asset investment
		Fiscal spending
		Passenger volume
	Regional development vigor	Freight volume
		Total retail sales of social consumer goods
Environmental comprehensive evaluation	Environmental pollution	Industrial production wastewater
		Industrial output value of sulfur dioxide emissions
		Industrial waste water discharge success rate
		Town life sewage treatment
	Environmental conditions	Hazard-free treatment rate of waste
		Industrial solid waste comprehensive utilization

RESEARCH PROCESS

Raw data processing

    This study selected China's 31 provincial units as the research object[5]. This is because, on the one hand, they have certain geographic range in space sense of independence, on the other hand is an independent economy in economic sense. Social economic and environmental data from China regional sustainable development of the database and the provincial statistical yearbook, 2011 China city statistical yearbook, China's environmental statistics yearbook in 2011.

Overall evolution characteristics

    Using the coupling coordination formula can be calculated for each year of 31 provincial unit area the size of the coupling and the coordination degree of numerical. In 2001-2011 economic and ecological environment system of the mean coupling between 0.5 0.8, the overall economic system and ecological environment in the running-in stage, are mainly distributed in the population of China's key industrial concentration area; Coordination degree of mean value is generally lower than the coupling, and its numerical value between 0.3 0.5, economic system and ecological environment system of coupling is moderate coordination coupling, and the average degree of fluctuation is not big, reflecting the two system coupling coordination pattern has certain stability.

    In terms of spatial pattern of the economic environment coupling, in 2011, China unit at the provincial level economic development and environmental pollution coupling spatial distribution is very uneven, coupling values range from 0.001 to 0.998 distributions[6]. The highest is Zhejiang, Jiangsu, and Ningxia are the lowest. All of China's provincial city unit coupling average of 0.190, as the low stage coupling; In terms of environmental coordination degree of spatial pattern, in 2011, the Chinese provincial unit economy system coordination degree scores ranged from 0.001 to 0.643 distributions. The highest food is a Sichuan, henna, Zhejiang, Ningxia is the lowest in. All of China's provincial city unit economic environment system coordination degree average of 0.14, for low level coordination phase.

    The spatial distribution of the coupling value according to the Chinese provincial units can see, the economic environment of high strength coupling region (coupling value in 0.8 above) are mainly distributed in the important city of

China's eastern coastal economic zone; The economic environment in the running-in stage area (coupling value between 0.5 ~ 0.8) mainly distributed in the population of China's key industrial concentration area; Moderate intensity coupling region (coupling value between 0.5 ~ 0.3) are mainly distributed in the rest of the provincial capital and some industrial base is located in the Midwest regional unit; Low intensity (coupling value below 0.3) coupling region, mainly for the far western region of local unit.

Chinese provincial unit economic coordination degree of environment characteristics of spatial distribution and the coupling of the distribution is slightly different[7]. Among the regions, highly coordinated region (coordination degree value in 0.5 above) only Beijing, Tianjin, Liaoning, Guangdong, Jiangsu, Sichuan, Zhejiang, Shandong, henna and other eight unit at the provincial level, and moderate coordinating region (coordination degree value is between 0.3 ~ 0.5) in group are distributed in the eastern coastal central as well as the core city of industrial concentration area, the population of the space area and highly coupled consistent; Low to moderate coordination area (coordination degree value is between 0.14 ~ 0.3) more distribution around the moderate coordination area, including regional unit of moderate coupling and part of the coupling between 0.2 ~ 0.3 regional unit; Low-grade coordination area (coordination degree value below 0.14) a wide range of area is larger, distribution in the far western region and central remote areas

Coupling of spatial pattern of evolution

In order to further analyze the coupling and the dynamic change of coordination degree, by combining ArcGIS 9.3 heavy classification tools, this paper conduct visualization processing of the data, the result is shown in Figure 1.
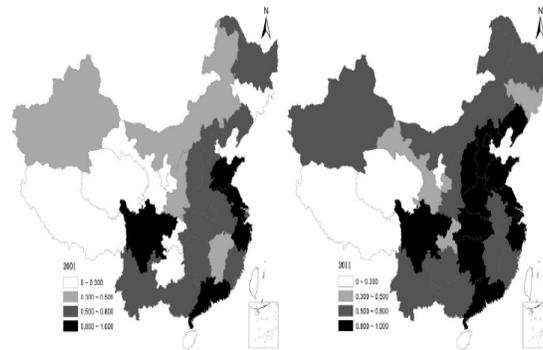

Figure 1 : Regional distribution of space coupling changes

Economic system and ecological environment system in 2001 in a low stage coupling of these areas are mainly concentrated in the west, most of the region ecological environment comprehensive

Evaluation index of g (x) is relatively high, but the economic comprehensive evaluation index of f (x) ranked relatively, the local superior ecological environment condition does not translate into economic advantage[8]; Economic system and ecological environment system in 2001 at a high level stage of coupling the region mainly located in the bohai rim, Yangtze river delta and the pearl river delta, in 2011, expanded to six provinces in central, reflect the overall economic system and the increase in the number of regional ecological environment system of high level coupling.

Coordination degree of spatial pattern of evolution

Coordination is the coupling relationship between economic system and ecological environment system combined into the overall look, more comprehensive than the coupling results, also more stable[9]. Economic system and ecological environment system coordination degree is higher, shows that the overall level is higher, the development of economy and ecological environment improvement, can promote each other between the opposite party to the other party get in the way of development, form each other containing, vicious circle. As can be seen from the Figure 2:
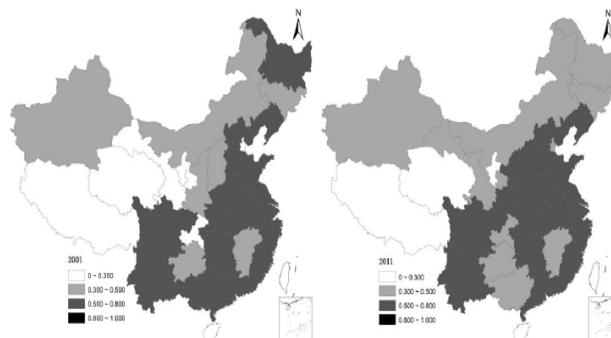
Figure 2 : Regional coordination degree of environment change of spatial distribution

In 2001, economic system and ecological environment system in a state of low coupling, mainly in the west, economic development is bad for improving ecological environment, the development of economy and ecological environment, to a certain extent improve a vicious circle between the situation[10]; Economic system and ecological environment system in 2001 in a highly coordinated coupling mainly in the central state of the region, the development of economy and ecological environment are basically able to form a virtuous cycle. In general, most provinces coordination degree in moderate coordination of the coupling condition and highly coupled coordination state, on the whole provincial economic system and ecological environment system coordination degree in the medium level, remains to be further improved.

Economic environment space of the coupling coordination degree classification

Comprehensive provincial unit coupling and coordination degree, classifying China's 31 provincial units, it can be divided into four type[11]. First is the economic environment harmonious area, namely the high coupling coordination area. Including Beijing, Shanghai, Guangdong, Tianjin and other places, the coupling is above 0.8, coordination degree above 0.5. It suggests that these areas are highly coupled to the economic and environmental harmony stage.

The second is the economic environment area, namely the high coupling and low harmonious regions. Mainly includes industrial agglomeration area and population comprehensive industrial base. These regional unit coupling is between 0.5 ~ 0.8, the coordination degree between 0.3 ~ 0.5.

The third is low coupling in harmonious regions, mainly including Inner Mongolia, Hebei, Shanxi, Shaanxi, Henan, Hunan, Anhui, Chongqing, Qinghai, Guangxi and other places., these regional unit coupling between 0.2 ~ 0.5, but the coordination degree under 0.3, is China's important coal, chemical industry, steel, metallurgy and other industrial raw materials production and processing bases.

Finally, it is the low coupling region in harmony. These areas are mainly distributed in the far western region and central remote areas, coupling and coordination degree are below 0.3, is the economic environment interaction of smaller area.

ANALYSIS OF DIFFERENT INDUSTRIAL STRUCTURE VARIANCE

Industrial structure characteristics of different areas

By calculating the industry output value proportion found on different type areas (TABLE 3):

TABLE 3 : Different types coupling of leading industry

Area Type	Leading industrial sector
Economic environment harmonious area	Communications equipment; Computers and other electronic equipment manufacturing (25.26%); transportation equipment manufacturing industry (8.13%); Electronic machinery and equipment manufacturing (6.93%)
Economic environment running area	Black metal smelting and rolling processing (9.16%); Electronic instruments and equipment manufacturing (7.9%); Transportation equipment manufacturing (7.11%); Chemical raw materials and chemical products (6.3%); General equipment manufacturing (6.1%);
Economic environment antagonism area	Chemical raw materials and chemical products (9.88%); Black metal smelting and rolling processing (8.73%); Agricultural and sideline products processing (7.01%); Non-metallic mineral products (6.31%)
Economic environment low coupling region	Oil processing (7.37%); Coking and nuclear fuel processing industry (6.62%); Coal mining and washing industry (6.1%); Electric power (6.52%)

First, the leading industrial economic environment in harmony with communication equipment, computers and other electronic equipment manufacturing, transportation equipment manufacturing, electric machinery and equipment manufacturing, general equipment manufacturing and other high-end equipment manufacturing industry is given priority to, accounts for about 48% of the total industrial output value in the areas. Indicates that these areas after nearly 30 years of rapid economic growth have crossed the pure pursuit of economic growth stage began to timely adjust the industrial structure and economic growth pattern, industrial structure mainly with high added value, low pollution, low energy, high and new technology industry, advanced manufacturing services. And the region's economic strength is higher, can take out a certain amount of money and technology for environmental pollution control and restoration, by economic feedback environment, gradually to the harmonious development of economy and environment.

Second, the economic environment antagonism in the industrial sector, steel, petrochemical, coal, building materials, electricity and other polluting industries has become main industry area, and occupy large proportion in the gross value of industrial output in the region. In 2008, the black metal smelting and rolling processing industry in their regions, chemical raw materials and chemical products, oil processing and coking and nuclear fuel processing industry, coal mining and dressing industry, non-metallic mineral products and electric power production and supply industry which accounts for about 40% in gross value of industrial output, and the rest of the regional leading industries, such as agricultural and sideline

products processing, electrical machinery and equipment manufacturing, textile industry and other industry output value proportion less than 25% of the total industrial output value accounted for area. Although the region's economic development level and economic strength is than the east coast and Midwest capital cities, but due to the rapid development of national economy in recent years growing demand for energy raw materials, driven by the region's economic development speed, increasing the size of resource development and processing, the strong coupling effect to the economic environment. However, due to the weaker in these regions, inadequate investment in environmental regulation and pollution control, lead to the local environmental pollution is very serious[12]. Therefore the areas are where the China's future environmental risk focuses.

Finally, the economic environment of low coupling region industrial structure, the primary products processing and production occupy the main body, leading industry mainly for steel, agricultural and sideline products processing, coal mining, chemical industry and building materials, and power generation accounts for about 60% of the total industrial output value in the areas. Due to relatively low level of economic development, the economy of the role of the environment is relatively small, not a threat.

Different polluting industry location quotient

Due to coal selecting, leather and fur products, paper making, oil processing and coking, rubber, plastic products, nonmetallic mineral products and black metal, non-ferrous metal rolling processing, electric power industries of large consumption of energy and resources, and discharge waste gas, waste water and waste residue, large-scale so in a lot of research is defined as "polluting industry". If these departments in regional industrial economy the proportion are larger, so the region economic development of resources and environment stress intensity is relatively large. Through analysis and calculation of 4 kinds of type "polluting industry" the proportion of industrial output value in regional, district "polluting industry" output "polluting industry" industry in the whole country the proportion of total output, as well as regional "polluting industry" relative to its gross industrial output value and the national average of location quotient, found in area of economic environment and economic environment antagonism district was also the polluting industry the most concentrated area. "Polluting industry" in these two kinds of output size of this kind of industrial output value accounted for the 70%, and "polluting industry" in the area proportion of gross industrial output value is above 25%. Especially in the economic environment antagonism "polluting industry output value accounts for its regional average of 35%, the proportion of gross industrial output value, and on the national polluting industry output value proportion of the total 30%, polluting industry location quotient is 1.3 on average, in the four regions (TABLE 4).

TABLE 4 : Polluting industrial sector of different

Area Type	Polluting department structure proportion	Polluting department area proportion	Polluting sector location quotient
Economic environment harmonious area	17.45	11.98	0.639
Economic environment running area	25.91	40.10	0.949
Economic environment antagonism area	35.47	29.75	1.299
Economic environment low coupling area	33.43	18.17	1.225

That the se areas not only is China's "polluting industry" concentrated area, at the same time in these areas, "polluting industry" has become the regional leading industries and pillar industries. If the region's economic development scale continuous growth, environment pollution due to the industrial development will continue to increase, resulting in the region will become the environmental pollution is most serious in China. As a result, the area must also be must attach importance to environmental pollution control and regulation of China region.

CONCLUSION

In this paper, through the establishment of comprehensive evaluation index system of regional economy and environment, using the coupling coordination degree model, for the economic development of China's regional unit and coupling coordination degree of environment pollution are analyzed in space. Studies suggest that at present China's national spatial basic can be divided into four types, namely economic environment harmonious area, the economic environment in area and economic environment, economic environment, antagonism low coupling region. But simple coupling analysis can only expresses the regional economy and the environment subsystem on the numerical scale sequence distribution relationships, and cannot really reflect the region economic development and material interaction relationship between the environmental pollution. Therefore, this article also supplemented to the four type of industry structure are analyzed, and found that the economic environment in area and economic environment antagonism the regional unit polluting industries

occupy larger departments, especially in the economic environment antagonism industry mainly in low added value, high pollution the polluting sectors such as mining, metallurgy, high polluting industries concentrated area is a typical low growth. The research results to China's environmental impact assessment for the future provide the scientific basis of the focus areas will be beneficial to the realization of the fine management.

But it is also found that using the physics coupling formula for coupling analysis of economic development and environmental pollution, can only see from numerical distribution law on both the synchrony in terms of scale, but cannot see how its internal relations of real interaction. The necessary analysis of industrial structure must also be supplemented, even technical and economic indicators analysis of energy and material consumptions per unit of output. This content will be the focus of future research.

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