DISCUSSION ON THE DESIGN OF COMPENSATION STANDARDS FOR REGIONAL ENVIRONMENTAL POLLUTION FROM THE PERSPECTIVE OF NEW STRUCTURAL ECONOMICS

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ABSTRACT

How to effectively protect the ecological environment while socio-economic development, to achieve the harmonious and sustainable development of human society and the natural ecological environment, has been paid more and more attention by governments and academic circles around the world. Therefore, the design of compensation standards for regional environmental pollution is proposed from the perspective of new structural economics. Based on the perspective of new structural economics, this paper provides a new explanation of the impact of fiscal decentralization on environmental pollution, according to the economic and technical indicators related to ecological environmental pollution, with the help of the subjective and objective empowerment method combined with the analysis of hierarchy method and entropy method, the weight of each ecological environment pollution evaluation index in the evaluation and division of ecological environmental pollution level is studied, and the comprehensive evaluation method is used to construct the ecological environment pollution technology rating evaluation model, and the compensation value of regional environmental pollution is finally obtained by combining the panel regression model. The method of this paper has wide applicability and significant advantages. The experimental results show that the COD emission of the North Water Source Area (QZ) of the Qingzhang River is 208t/a, and the upstream of the drinking water source area needs to compensate 3.88 million yuan downstream for water quality and water ecological restoration.

KEYWORDS

New structural economics; Ecological environment; Fiscal decentralization; Compensation standards; Panel regression model

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1. INTRODUCTION

With the rapid economic growth, the large-scale development and consumption of resources, and the increasingly serious damage to the environment, environmental problems such as the destruction of species habitats, the sharp decline in biodiversity, and the decline in ecological functions have become one of the important ecological problems that plague the sustainable social and economic development of all countries in the world [1-3]. In this process, the environmental problems brought about by the development of the industry have attracted the attention of people from all walks of life such as governments, non-governmental organizations, and scientific research, and the contradiction between environmental protection and economic development has become one of the key issues in the region [4-5]. To enhance ecological functions and improve the ecological environment, in addition to providing positive externalities (such as returning farmland to forests and grasslands to provide ecosystem services such as soil and water conservation), it is often necessary to reduce negative externalities, such as reducing resource development and pollution emissions in industries with high environmental risks in the region [6-9]. In particular, high-environmental risk industries located in important ecological function zones even need to be completely withdrawn. In the short term, protecting the environment requires sacrificing certain economic interests, and even "shutting down and transferring" enterprises that have previously obtained access permits to restrict their production and development [10]. For example, to provide high-quality and sufficient water resources downstream, upstream and midstream mining enterprises need to reduce production capacity, reduce production and discharge, and give up some of their development authority. To maintain the continuity of water flow and protect important aquatic biological resources, hydropower enterprises located in nature reserves or important ecological function areas need to be closed [11-13].

As an institutional arrangement to regulate the relationship between environmental damage and the protection of the interests of the main body of the ecological environment, ecological compensation has become an effective way to protect the ecological environment [14]. Ecological environment compensation mainly refers to the maintenance of ecosystem stability by improving the ecosystem status of the damaged area or establishing new habitats with comparable ecosystem functions or quality, to compensate for the decline or destruction of existing ecosystem functions or quality caused by economic development or economic construction [15-18]. In the ecological compensation mechanism, the subject and object of compensation, the standard and compensation method of compensation is a core issues, of which the determination and accounting of ecological compensation standards is a difficult point of ecological compensation mechanism [19-20]. The research on ecological compensation in China began in the 1980s on ecological compensation in the ecological sense and the exploration of ecological compensation in the economic sense, and after the United Nations Conference on Environment and Development, it entered the active theoretical discussion stage based on environmental loss compensation and became a hot issue in all sectors of society in China [21-24]. Due to the low existing ecological compensation standards in China and the inconsistent cost accounting of compensation standards, it is of great significance to build an effective ecological compensation standard cost accounting system to provide the main basis for the formulation of ecological compensation standards to protect the interests of relevant entities and promote the healthy and benign development of the ecological environment [25].

Literature [26] aimed at the current problems of single ecological compensation standards and limited scope of determination. This paper proposes indicators such as the utilization of pollution footprint, pollution footprint efficiency, environmental carrying capacity, regional average absorption capacity and economic benefit loss value. Establish a standard model of ecological compensation. Taking 31 provinces in China as examples, an empirical analysis was conducted. First, set each province as a group. Compare pollution footprints within the group with national pollution footprints to determine the subject-object of compensation. Secondly, the ecological compensation model is used to calculate the ecological compensation (compensation) standard of each group (province), combined with the per capita pollution footprint and pollution footprint efficiency, and the provinces are divided into high, low, low, low and low combinations. Finally, personal suggestions are put forward for different combinations, the combination of low and high is the ideal combination, the combination of high and high should reduce pollution, adjust the industrial structure, and the combination of high and low should be supported by policies to improve the efficiency of the regional ecological environment, and the combination of low and low should be through scientific and technological progress. Improve regional output efficiency. Literature [27] believes that the evaluation of the comprehensive benefits of ecological compensation in water source areas is the key to scientifically formulating the ecological compensation mechanism and ensuring the effective operation of ecological compensation, and is also an important reference for determining reasonable compensation standards. Based on the influencing factors of all aspects, a comprehensive benefit evaluation system for ecological compensation in water sources was formulated, including 15 evaluation indicators such as ecological benefits, economic benefits and social benefits, and monetary value accounting was carried out on the ecological compensation benefits of Yunmeng Lake in Shandong Province using the market value method and the shadow engineering method. After the implementation of the ecological compensation of Yunmeng Lake, the ecological benefits increased by 106.4975 million yuan, the economic benefits were 77.1859 million yuan, and the social benefits were 56.0318 million yuan, with significant comprehensive benefits, but there were also problems such as education, tourism and other benefits were not obvious, and the ecological, economic and social benefits increased unevenly. In the future, we should pay attention to the economic and social driving role of ecological compensation in water source areas, enhance interaction with farmers, implement differentiated compensation, and extend the period of ecological compensation to promote the sustainable development of ecological compensation in water source areas. In literature [28], a standard model of ecological compensation based on pollution footprint was constructed, and the ecological

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compensation standard in Guangzhou was studied using this model: taking the emission of four major pollutants as the accounting goal, the population was divided into three major groups according to the three major industries, the per capita pollution footprint and per capita pollution footprint efficiency of the three major groups were calculated, and the compensation or compensation standards of the three major groups were calculated based on the average ecological status of Guangzhou. The results show that Guangzhou's primary and tertiary industries should receive ecological compensation of 67.379 billion yuan and 1926.728 billion yuan respectively due to the transfer of pollution footprints, while the secondary industry should pay 207.037 billion yuan in ecological compensation due to the excessive occupation of ecological footprints. The study of ecological compensation standards based on pollution footprints attempts to introduce pollution footprint theory into the study of ecological compensation standards, which can not only enrich the connotation of ecological footprint theory but also provide a useful reference for the study of ecological compensation standards. Literature [29] reveals the willingness and payment level of farmers in Yongdeng County, Gansu Province, to compensate for agro-ecological compensation, and provides a basis for the government to carry out relevant agro-ecological construction in the future. Based on the questionnaire survey, the conditional value assessment method (CVM) was used to analyze the willingness and payment level of farmers in Yongdeng County for agroecological compensation. Farmers in Yongdeng County have good ecological cognition and willingness to compensate. The number of farmers willing to compensate reached 87.76% of the total number of people surveyed, and the average level of agricultural ecological compensation payment reached 52.11 yuan per capita. The degree of importance affecting farmers' willingness to pay for agricultural ecological compensation is, in order: the degree of education> the importance of per capita annual net income> the importance of the ecological environment> the degree of impact on themselves> the number of days of migrant work> the degree of environmental concern> whether to manage the geographical location of > age >area. Farmers in Yongdeng County have a strong willingness to compensate for agricultural ecology, and the level of payment is in line with the actual situation, which is affected by personal cognition and per capita income. Literature [30] first expounds on the meaning and significance of watershed ecological compensation, then analyzes the subjects and objects in the process of watershed ecological compensation, introduces and analyzes the current ecological compensation methods of river basins, and finally explains the standards and mechanisms of watershed ecological compensation, to ensure the objectivity of the ecological compensation process of river basins and achieve the role of protecting the ecological environment of river basins. The above literature explains the significance of the study on ecological compensation standards for economic development and ecological benefits in various places, and the environmental information and value are not included in the accounting scope, and the research perspective is relatively narrow. Therefore, how to embed the basic methods of environmental pollution into the accounting of ecological compensation standards, establish a complete set of ecological compensation standard cost accounting

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systems, and provide a meaningful reference for the determination of ecological compensation standards is a focus of text research.

From the perspective of new structural economics, this paper defines the concepts of ecological pollution compensation and market-oriented models, refines and summarizes the relevant theories, and proposes a theoretical model for the design of market-oriented ecological pollution compensation standards. At the technical level, through data and information collection and application of subjective and objective empowerment methods to set weights, the comprehensive evaluation model is used to assess the technical level of ecological and environmental pollution, and the compensation value of regional environmental pollution is obtained through the panel regression model, to better guide policy formulation and implementation and promote ecological development.

2. NEW STRUCTURAL ECONOMIC ANALYSIS AND CHARACTERISTIC FACTS

2.1. FISCAL DECENTRALIZATION

New Structural Economics (NSE), proposed and advocated by Lin Yifu, emphasizes that economic development is a process of continuous change in industry, technology, infrastructure, and institutional structure, in which there must be both an "efficient market" and a "promising government" [31]. Among them, the government itself is the most important institutional arrangement in economic development, and the development strategy it formulates plays an important role in the national economy. Starting from the degree of matching between the industrial structure and the factor endowment structure, it is proposed to classify the various economic development policies of the government into different development strategies. The concept of development strategy is a highly abstract summary of the various economic policy actions of the government. According to whether it is in line with comparative advantage, it is divided into a development strategy that follows comparative advantage and a development strategy that violates comparative advantage. Specifically, (1) under the development strategy of comparative advantage, the government's economic policies are to select the corresponding industry, product and technology structure to support the enterprise by selecting the corresponding industry, product and technology structure according to the local factor endowment structure of the backbone, and the enterprise chooses to enter the industry that meets the comparative advantage and the specific technology production product according to the relative price information of the factors in the market. Since enterprises are entering industries that are in line with local comparative advantages, such enterprises are self-sustaining and able to survive without external support. (2) On the contrary, if the development strategy contrary to comparative advantage is adopted, and the government's various economic policies ignore the comparative advantages determined by the endowment structure of the region, thus causing the industrial structure of the region to deviate from the optimal structure, once the enterprise enters an industry that does not have a relatively favorable heat, and the products produced are not competitive in the market, then the type of enterprise is not self-sustaining, and at this time, if the enterprise wants to survive in the fierce market competition, it can only be maintained through a series of economic distortions such as government subsidies and tax incentives.

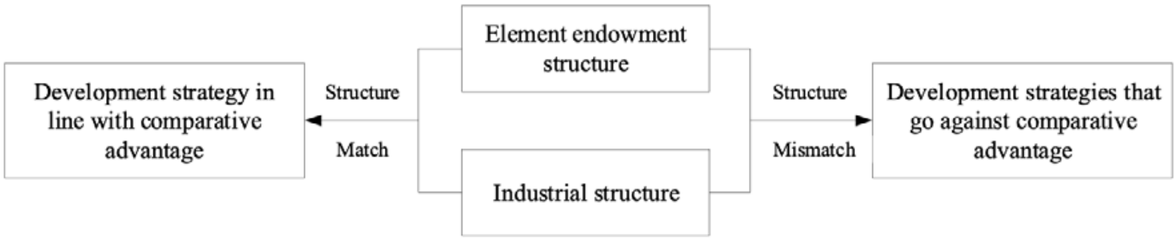

Figure 1. Conceptual definition of a development strategy

Conceptually, fiscal decentralization refers to the process of decentralization of some fiscal management and decision-making power by the central government to local governments, so a certain degree of fiscal decentralization always corresponds to the fiscal autonomy owned by a certain level of government. Due to the wide geographical area and obvious regional differences in China, the resource endowments and potential relatively favorable heat of each region are different, and only by fully grasping the information such as the resource endowments of each region and the constraints it faces can we formulate a development strategy that is in line with its relatively favorable heat [32]. In this context, if the central government directly formulates development strategies for each region, due to information asymmetry and excessive cost of collecting and processing information, it is difficult for the central government to formulate a development strategy that meets the comparative advantages of each region's resource endowment conditions, resulting in a "one-size-fits-all" situation. Compared with the central government, local governments have obvious information and enthusiasm, and they have a better understanding of the stage of development that the local government is in, thus making local governments more efficient than the central government in formulating development strategies. Therefore, under the fiscal decentralization system, the higher the degree of regional decentralization, the greater the autonomy of the local government over economic development, and the higher the probability of it following a more favorable development strategy according to the information held by the local government. The more the development strategy is in line with comparative advantage, the less environmental pollution will be caused.

If the degree of regional fiscal decentralization is low and the central government interferes greatly with local development, then the possibility of local development strategies violating their comparative advantages is very large, resulting in distortion of the local industrial structure and deviation from its endowment structure, and the enterprises in it cannot live on their own, and while the enterprises cannot obtain profits, the overall regional economy is also developing slowly. However, under the political promotion and economic incentive of GDP-oriented, to achieve the goal of economic development, local government officials have to adopt a series of distorting mechanisms such as lowering environmental access barriers to attract foreign investment, relaxing the level of environmental regulations, distorting the structure of fiscal expenditure, and insufficient environmental governance to promote economic growth. The economic growth stimulated in this context is unsustainable, on the one hand, enterprises cannot live on their own, even if environmental constraints tighten, they cannot internalize environmental pollution, and environmental soft constraints appear. On the other hand, the fiscal revenue of local governments is not enough to pay for environmental governance, which leads to the deterioration of environmental pollution problems.

Based on the above theoretical analysis, the research hypothesis is put forward that the higher the degree of fiscal decentralization, the more the development strategy is in line with its relatively favorable heat, and the environmental pollution problem will be less light.

2.2. CHARACTERISTIC FACTS

Before conducting an empirical analysis, the preliminary relationship between fiscal decentralization and development strategy is first observed by describing characteristic facts. The statistical relationship between fiscal decentralization and development strategy is obtained based on the level data using the Fiscal Autonomy (FDEC1) and the Technology Choice Index (TCIR) as proxy variables for fiscal decentralization and development strategy, respectively [33]. The scattering points of fiscal decentralization and development strategies are shown in Figure 2.

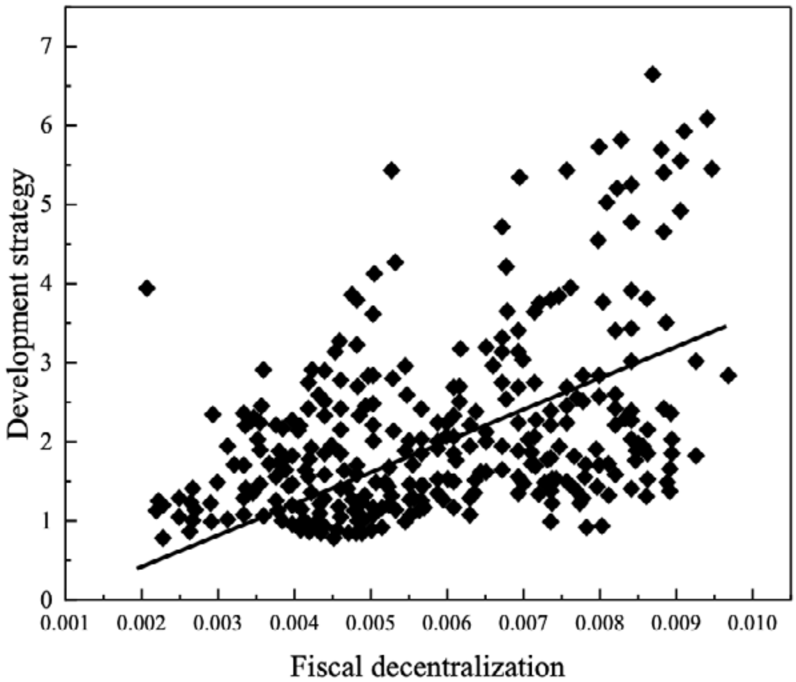

Figure 2. Scatter plot of fiscal decentralization and development strategies

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From the perspective of scatter chart 2, fiscal decentralization is positively correlated with the development strategy, and its correlation coefficient is 0.502, indicating that the higher the degree of fiscal decentralization, the higher the degree to which the local development strategy follows its comparative advantage. Further, from the perspective of the nuclear density map of fiscal decentralization and development strategy in the eastern, central and western regions of China, as shown in Figures 3 and 4.

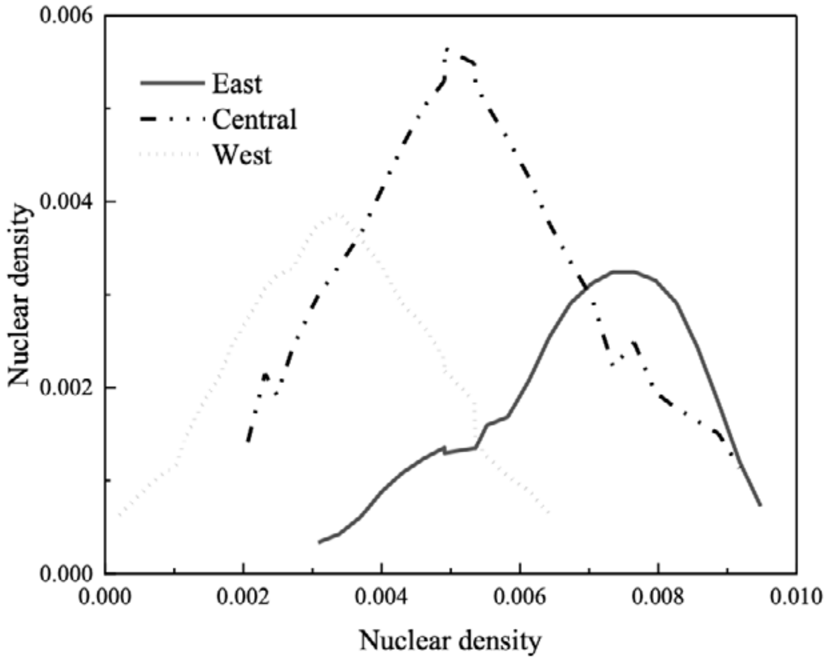

Figure 3. The nuclear density of fiscally decentralized sub-regions

In Figure 3, the degree of fiscal decentralization in the eastern region is generally higher than that in the central and western regions, with the average being 0.722 in the eastern region, 0.468 in the central region and 0.389 in the western region.

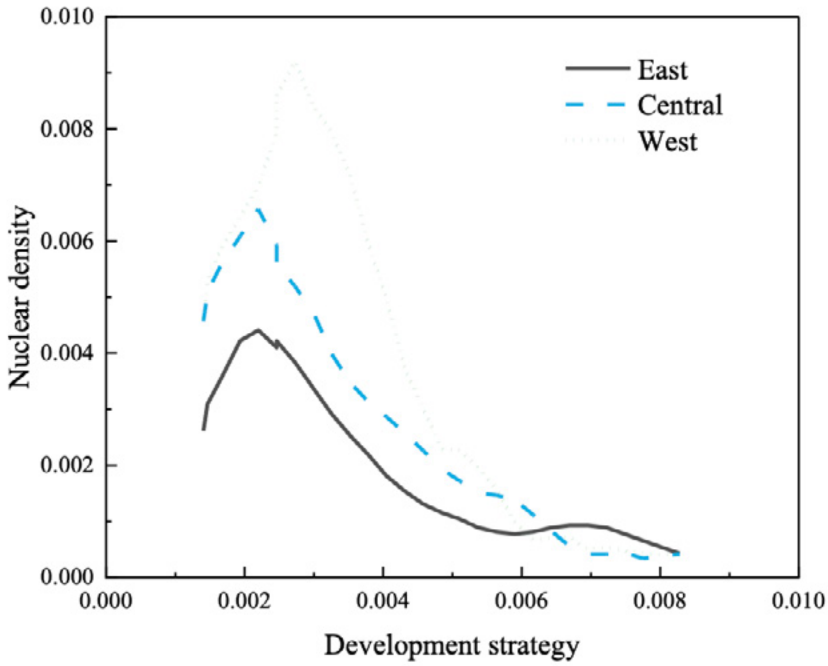

Figure 4. The subregional nuclear density of development strategies

In Figure 4, the distribution of the TCIR index in the eastern region is generally biased to the central and western regions, that is to say, the development strategy in the eastern region is less distorted than in the central and western regions, and on average, the eastern region is 0.243, the central region is 0.007, and the western region is 0.005. It can be seen from this that the basic characteristic facts can support the theoretical expectations of this paper.

3. REGIONAL ENVIRONMENTAL POLLUTION COMPENSATION STANDARD DESIGN

3.1. COMPENSATION STANDARD SYSTEM DESIGN PRINCIPLES

Due to the variety and complexity of the factors for evaluating the ecological environment pollution level, when designing the ecological environment pollution level index system, it is necessary to select the indicators that cause ecological environmental pollution from multiple aspects and multiple angles to meet the systematic assessment and comparison [34]. The specific design principles have the following aspects:

1. Comprehensiveness. Comprehensively and objectively reflect the pollution status of the ecological environment. The designed index system must be able to reflect the degree of ecological environmental pollution from all aspects, which is directly related to the quality of the entire system.

2. Scientific. The indicator system must be based on science and fully reflect the internal relationship between ecological environmental pollution and various indicators. The methodological science of determining the weight of indicators and the grading of early warnings ensure the authenticity and objectivity of the system;

3. Operability. The selected indicators should have reliable sources and ensure the availability of data, the established indicator system is concise and easy to operate and understand, and the internationally common names, concepts and units are adopted as far as possible, which is conducive to the actual operation of relevant personnel.

3.2. DETERMINATION OF THE WEIGHT OF THE INDICATOR SYSTEM

Environmental pollution refers to the phenomenon that human beings directly or indirectly emit substances or energy that exceed their self-purification capacity into the environment, thereby reducing the quality of the environment and adversely affecting the survival and development of human beings, ecosystems and property [35]. Since

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this article mainly discusses the ecological pollution compensation standard, industrial enterprises in the external discharge of pollutants by the traditional view mainly include air pollution, water pollution and solid waste pollution, so in the design of the ecological environment pollution level evaluation index system, this paper combined with the above indicators design ideas and original, to comprehensively and objectively reflect the ecological environment pollution status, according to the "China Environmental Statistics Yearbook" disclosed pollutant emission data [36], design the following three types of pollutant indicators: air pollution indicators, Indicators of water pollution and indicators of solid waste pollution.

Due to the different roles of the above index factors in the index system, the degree of impact on ecological environmental pollution is different, to distinguish their differences, certain mathematical methods should be used to determine the weight values of each evaluation index. The reasonableness or non-validity of the weight determination of the indicators is directly related to the accuracy and meaning of the evaluation results. This paper adopts a subjective and objective empowerment method that combines the analytic hierarchy method with the entropy method. The analytic hierarchy method is a combination of qualitative and quantitative, systematic, hierarchical analysis method, so that people's thinking process is hierarchical, layer by layer comparison of relevant factors and layer by layer to test whether the comparison results are reasonable, to provide a convincing quantitative basis for analytical decision-making. However, in recent years, the analytic hierarchy method has been constantly questioned by the excessive subjectivity of the weight, so this paper uses the entropy weight method to determine the weight based on the analytic hierarchy method, and finally averages the weight values obtained by the two methods to obtain a more scientific and reasonable weight value. Regarding the emergence of entropy law, first of all, the German physicist Clausius introduced the concept of "entropy" into the field of thermodynamics in 1855 to describe the degree of chaos in the thermal system, and then developed into "information entropy" by Shannon, the founder of information theory in the United States, to quantify the size of the amount of information described, and then the social sciences began to apply "entropy" to the process of determining weights in multi-objective decision-making, and the academic community generally defined the method of determining the weight as the entropy law [37]. The entropy weight method is determined according to the size of the amount of information reflected by the evaluation object, which has accuracy and objectivity and has been well applied in various research fields. The ecological environment pollution level index system is shown in Figure 5.

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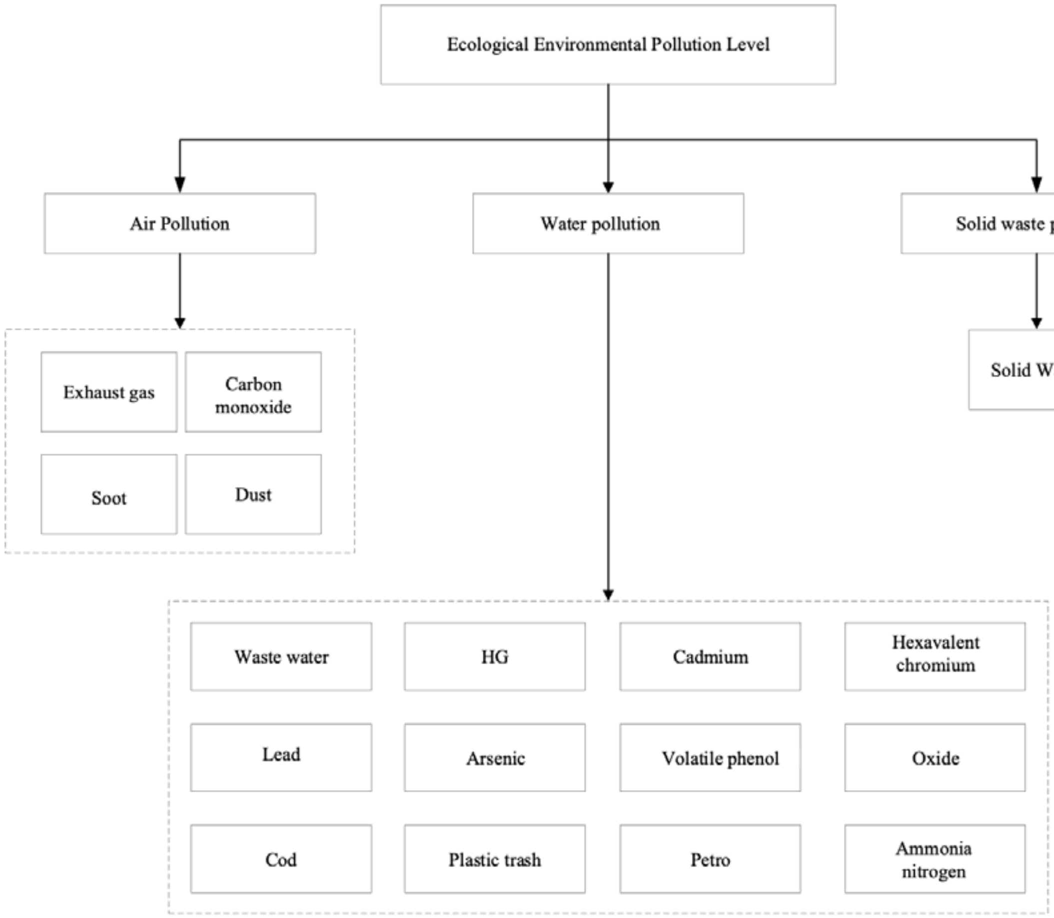

Figure 5. Ecological environment pollution level index system

In Figure 5, the influencing factors of ecological environmental pollution caused by unnatural factors are analyzed, and the indicators of air pollution, water pollution and solid waste pollution are extracted. The design of ecological and environmental pollution level indicators involves multidisciplinary applications such as atmospheric science, ecology, economics, management, accounting, and mathematical statistics. Mainly from the perspective of the influencing factors of the ecological pollution rating evaluation index system design and compensation standards, the design of market-oriented ecological pollution compensation standards is theoretically analyzed, and the comprehensive evaluation model and panel regression model are used to conduct technical analysis of the design of market-oriented ecological pollution compensation standards.

To illustrate the basis for judging the importance of the indicators, this paper first takes a 1--9 scale according to the scale method proposed by TL. Saaty, as shown in Table 1, and uses a_{ij} to represent the comparative results of the i factor relative to the j factor, then $a_{ij} = \frac{1}{a_{ji}}$, and establishes the judgment matrix between the levels of the 16 factors currently considered in the ecological environment pollution level evaluation index system. This is shown in Table 2.

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Table 1. Saaty scale method

Scale	Meaning
1	The influence of factor i is the same as that of factor j
3	The influence of factor i is slightly stronger than that of factor j
5	The influence of factor i is stronger than that of factor j
7	The influence of factor i is obviously stronger than that of factor j
9	The influence of factor i is absolutely stronger than that of factor j
2,4,6,8	The influence of the i-th factor relative to the j-th factor is between the above two adjacent levels

Table 2. Judgment matrix table

A	B_1	B_2	B_3
B_1	a_{11}	a_{12}	a_{13}
B_2	a_{21}	a_{22}	a_{23}
B_3	a_{31}	a_{32}	a_{33}

Hierarchical single sorting is the process of determining the degree of influence of the lower factors on a factor in the upper layer, using weights to express the degree of influence, calculating the maximum eigenvalue of the matrix λ_{max}, and its corresponding normalized feature vector $k = (k, k_2, \ldots, k)$, and the eigenvector $\sum k_j = 1$ is the index weight.

When determining the order of a matrix is large, it is often difficult to construct a matrix that satisfies consistency. However, judging the matrix should deviate from the consistency condition by a degree, for this reason, it is necessary to identify whether the judgment matrix is acceptable, which is the connotation of the consistency test. Definition of consistency indicator $CI = \frac{\lambda_{max} - n}{n - 1}$, randomness indicator RI and the degree of the judgment matrix, in general, the larger the order of the matrix, the greater the probability of random deviation of consistency, which can be obtained by looking up the table. In general, when the consistency ratio is $CR = \frac{CI}{RI} < 0.1$, the judgment matrix is considered to pass the consistency test, otherwise it does not have a satisfactory one-RI consistency. From this, we calculate the weight results of each level of the indicator.

Total sorting is performed layer by layer from top to bottom on a single-sort basis. According to the weighted combination of the weighted results of each level of

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indicators calculated above, the weighted values of the comprehensive evaluation indicators $k = (k_1, k_2, \ldots, k_{16})$ and $\sum_{j=1}^{16} k_j = 1$ are obtained.

This paper assumes that the evaluation matrix of the entropy weight method is $X = (x_{ij})_{m\times n}$, where the evaluation object is $m(0 < i < m)$, which represents the evaluation index $n(0 < 1 < n)$, and x_{ij} represents the original value of the j index of the i evaluation object. The calculation step is divided into three steps.

Step 1: standardize the processing, the formula is:

$$y_{ij} = \frac{x_{ij} - \min_i\left(x_{ij}\right)}{\max_i\left(x_{ij}\right) - \min_n\left(x_{ij}\right)} \tag{1}$$

Where, max$_i(x_{ij})$ and min$_i(x_{ij})$ represent the maximum and minimum values of the j indicator in the i evaluation object, respectively.

Step 2: calculate the entropy of the indicator, the expression is:

$$r_{ij} = y_{ij} / \sum_{j=1}^{n} y_{ij} \tag{2}$$

$$e_j = -\frac{1}{\ln m} \sum_{i=1}^{m} r_{ij} \ln r_{ij} \tag{3}$$

Step 3: Determine the entropy weight t_j of the indicator:

$$t_j = \left(1 - e_j\right) / \sum_{j=1}^{n} \left(1 - e_j\right) \tag{4}$$

On the one hand, although the process of determining weights by the analytic hierarchy method has the advantages of clarity of hierarchy and the combination of quantitative and qualitative, the analytic hierarchy method will inevitably cause the subjectivity of the index weights through artificial scoring by experts when constructing the two-two comparison judgment matrix. On the other hand, the entropy weight method is determined according to the size of the amount of information reflected by the evaluation object, which has accuracy and objectivity and has been well applied in various research fields, which can well avoid the weakness of the analytic hierarchy method.

From the perspective of the victim entity of ecological environmental pollution, the severity of ecological environmental pollution is subjective; From the technical point of view of ecological environmental pollution, the severity of ecological environmental pollution is objective, so considering the characteristics of both subjectivity and

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objectivity of ecological environmental pollution, before evaluating the ecological environment pollution level, the setting of the weight of ecological environmental pollution indicators also adopts the subjective and objective empowerment methods combining the analytic hierarchy method and the entropy rights method, see Table 3. The calculation formula is:

$$\omega_j = \left(k_j + t_j\right)/2 \quad (5)$$

$$j = (1,2,\ldots,16) \quad (6)$$

Table 3. Weight setting of ecological environment pollution level evaluation index

Pollution classification	Index system	Index weight w_j
Air pollution	Waste gas (100 million standard cubic meters)	w_1
	Sulfur dioxide (10000 tons)	w_2
	Smoke and dust (10000 tons)	w_3
	Dust (10000 tons)	w_4
Water pollution	Waste water (10000 tons)	w_5
	Mercury (ton)	w_6
	Cadmium (ton)	w_7
	Hexavalent chromium (ton)	w_8
	Lead (ton)	w_9
	Arsenic (ton)	w_{10}
	Volatile phenol (ton)	w_{11}
	Cyanide (ton)	w_{12}
	Chemical oxygen demand (ton)	w_{13}
	Petroleum (ton)	w_{14}
	Ammonia nitrogen (ton)	w_{15}
Solid waste pollution	Solid waste (ton)	w_{16}

3.3. SYSTEM EVALUATION AND POLLUTION LEVEL DIVISION

After determining the weights of each ecological environment pollution index, it can be used, and certain technical methods can be synthesized on the ecological environment pollution level index system, and the evaluation is combined, and the weights of the ecological environmental pollution evaluation indicators can be determined through the subjective and objective empowerment method. Therefore, it is objective, accurate and simple to quantitatively evaluate the pollution level of the ecological environment. This paper adopts a comprehensive evaluation model, which takes the following form:

$$P_j = \sum_{j=1}^{16} \omega_j y_{ij} \tag{7}$$

Among them, $P(0 < i < m)$ is the comprehensive evaluation index of the ecological environment pollution level of the polluting entity in the i year, and $\omega_j(0 < j < 16)$ is the weight of the j evaluation index, y_{ij} has the same meaning as above.

Obviously, by such processing, it is possible to make $0 \leq p \leq 1$. Since China does not yet have a comprehensive rating evaluation standard for air pollution, water pollution and solid waste pollution, this paper considers the two extremes of ecological pollution when formulating evaluation standards. When the polluting entity has no pollutant discharge, the ecological and environmental status is excellent, and the comprehensive evaluation index is 0 at this time. When the total amount of pollutants discharged by polluted entities is large, causing extreme damage to the ecological environment and production and life, the degree of ecological environmental pollution will be very serious, and the comprehensive evaluation index is 1 at this time. We will be the worst degree of ecological environmental pollution grade set as P_1, the comprehensive evaluation index set as $\left(P_{n-1},1\right]$, the lightest degree of ecological environmental pollution grade set as R_n, the comprehensive evaluation index set as $\left[0,P_1\right)$, of which the specific value of $P(i = 1,2\ldots,n-1)$ can be determined according to the above comprehensive evaluation formula and combined with a large number of sample data values, so we will divide the ecological environmental pollution into n grades according to the comprehensive evaluation index, and according to the development of the situation and the effect of measures, the evaluation results are dynamically adjusted, and the ecological environmental pollution can be upgraded or degraded. This is shown in Table 4.

Table 4. Comprehensive evaluation index and ecological environment pollution level

A comprehensive index value of evaluation index	Ecological environment pollution level	Severity of ecological environment pollution
$P_{n-1} < P \leq 1$	R_1	Very poor (very serious)
⋮	R_2	Poor (severe)
$P_1 \leq P < P_2$	⋮	⋮
$0 \leq P < P_1$	R_n	Excellent (slight)

3.4. THE STANDARD MODEL OF ECOLOGICAL POLLUTION COMPENSATION

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3.4.1. VARIABLE AND SAMPLE SELECTION

To facilitate the determination of the ecological pollution compensation standard from the economic perspective, it can be assumed that in the case of a certain income of the injured economic entity, the environmental cost of the economic entity caused by the ecological environment pollution must be reflected in the decline in the total profit of the injured economic entity, for this reason, the total profit of the injured economic entity is taken as the dependent variable, and the ecological environment pollution level of the polluting entity determined above is taken as the independent variable, and the corresponding control variables need to be selected due to a large number of other influencing factors of the change in the total profit of the affected economic entity. The specific situation of the control variable needs to be determined by the specific research object and combined with the relevant financial theory, such as the selection of the corresponding control variables of the industry and the enterprise will be completely different.

Based on the above-mentioned classification of ecological and environmental pollution levels, considering that China's environmental economic statistics have just started, and environmental and economic data are seriously lacking, so to expand the sample size, make the estimation results accurate, consider the panel data established by collecting market-oriented ecological pollution standards, and the data source can conduct field research and investigation by selecting representative, long span time, and a certain number of polluted areas (such as downstream or downwind areas) polluted objects (such as land) and units (such as listed enterprises).

Table 5. variable design and explanation

Variable	Mark	Interpretative statement
dependent variableTotal profit of the affected economic entity	PROFIT	Total profits of economic entities in each year within the sample time span
Explanatory variable Pollution grade index of pollutant discharge entity	P	The Eco-environmental pollution grade index of pollutant discharge entities can be obtained according to the above comprehensive evaluation model. If there are many pollutant discharge entities, in order to avoid too many variables, the average value of Eco-environmental pollution index can be taken according to the pollutant discharge entities
control variable Other major variables affecting the total profits of the affected economic entities	Controis	The specific situation of control variables depends on the specific research object and the theory of related disciplines. For example, the selection of corresponding control variables for industries and enterprises will be quite different

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3.4.2. PANEL REGRESSION ANALYSIS

Through the above analysis, the following panel regression model is established in this paper to investigate the degree of influence of the ecological environment pollution level index of polluting entities on the total profits of the affected economic entities:

$$PROFIT_{it} = \alpha_{it} + \beta_{it}P_{it} + \gamma_{it}\ Controls_{it} + \varepsilon_{it} \tag{8}$$

Where $i = 1,2,\cdots,n$ represents the number of cross-sections and $i = 1,2,\cdots,m$ represents a total of m time series from year 1 to year m. $PROFIT$ is the total profit of the injured economic entity in the m year to the 1st year, P is the ecological and environmental pollution level index of the polluting entity from the 1st to the m year, and $Controls$ is a series of control variables. In addition, before performing panel data regression analysis, it is necessary to consider many problems such as variable collinearity, heteroscedasticity, sequence correlation, and cross-section correlation.

3.4.3. ECOLOGICAL POLLUTION COMPENSATION STANDARDS

Will make the sample data into the panel regression model, the unknown parameters, get the upper hand area) (upstream basin drainage entity (P) discharge pollutants reduced after the ecological pollution poses a disadvantage to rank index per unit area (downstream) suffer entity (E) economic harm the pollution of ecological compensation standard pollution (that is, the marginal cost) calculation formula:

$$EC = \frac{\partial(PROFIT)}{\partial P} = \beta \tag{9}$$

The recovery cost calculation formula is as follows:

$$P_0 = 10^{-5} \times D/\left(C_i - C_0\right) \tag{10}$$

Where, P_0 is the recovery cost, and the unit is 100 million yuan /t; D is the sewage treatment cost, and the unit is yuan /t; C_i is the COD concentration of inlet water, and the unit is mg/L; C_0 is the COD concentration of outlet water, and the unit is mg/L.

The calculation formula of the ecological compensation standard of water source based on water environmental capacity is:

$$P = P_0(M - M_0) \tag{11}$$

It is believed that the external impact of ecological pollution acts can be regarded as a pollution right, the property rights of the parties to the ecological pollution acts can be clearly defined, and the ecological pollution compensation standards are determined by the virtual "ecological pollution rights trading market" formed by the two

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parties, and the numerical size needs to be measured in combination with the amount of pollutant discharged by the polluter exceeding the standard and the economic value loss of the injured party. In the future market-oriented ecological pollution compensation practice, the two sides can also bargain for some of the differences until the price acceptable to both sides is reached, so that the "visible hand" of the government is gradually replaced by the "invisible hand" of the "ecological pollution compensation" market.

According to the ecological pollution compensation standard from the economic perspective, if ecological environmental pollution occurs, the amount of ecological pollution compensation V_{ij} under the economic perspective is calculated according to the following steps:

1. Judge the ecological environment pollution grade $R_j(j = 1,2,\cdots,n)$, and the specific value P;
2. Panel regression analysis was used to determine the marginal cost of ecological environmental pollution suffered by the affected economic entity, and the specific value was EC;
3. According to the above criteria, determine the economic loss $V_{ij} = \beta_{ij}P_j$ of the affected economic entity caused by ecological environmental pollution, namely, obtain the compensation amount of regional environmental pollution from the perspective of new structural economics.

4. RESULTS AND ANALYSIS

In this paper, we take the Zhangwei South River Basin as an example, the Zhangwei South Canal water system originates from the Taihang Mountains, is one of the five major river systems in the Hai River Basin, flows through the five provinces and cities of Jin, Hebei, Henan, Lu and Tianjin, with a basin area of 38,000 km. Among them, the upstream mountainous area is 25,000 km, the middle and lower reaches of the plain area are 13,000 km, the Zhangwei South Canal is composed of two major tributaries of the Zhanghe River and the Weihe River, the two rivers are called the Wei Canal after the confluence of Xuwancang in Guantao County, Hebei Province, and are divided into the South Canal (the mainstream of the Haihe River) and the Zhangwei New River (into the Bohai Sea) through the Sinu Temple hub, and the important water source protection areas of the Zhangwei South Water System are the Zhangwu Reservoir (AY) of Anyang City, the Water Source Area of Hebi City (HB), the Qingzhang River Hebei Water Source Area (QZ), the Yuecheng Reservoir (YC), and the Qingzhang Dongyuan Water Source Area (QZD). Most of these water source protection areas are located upstream of the river basin, shouldering the responsibility of providing excellent water quality, sacrificing some development opportunities, and in the case of providing excellent water quality, the downstream should make ecological compensation for these areas to compensate for the loss of upstream

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areas; However, the overuse of water resources and the disorderly discharge of sewage by some upstream water-using units will cause serious water pollution accidents, sacrificing the right to use water resources downstream, and using compensation measures based on the perspective of new structural economics to discuss regional environmental pollution, the main body of ecological compensation can be clarified and provide a basis for the formulation of ecological compensation standards.

Based on the actual data collected, the main water source areas of the basin are analyzed, as shown in Table 6. The environmental capacity of the main drinking water source protection area in the sub-basin of the Zhangwei South Canal was calculated, and the results are shown in Figure 6.

Table 6. The main water source areas of the Zhangwei South River Basin

Water source area	Length of reach (m)	flow (m^3/s)	Current Speed (m/s)	COD degradation coefficient (1/d)
Anyang Zhangwu reservoir	5	4	0.1	0.25
Hebi water source area	48	3.2	0.2	0.25
Qingzhang River Hebei water source area	45	0.82	0.27	0.25
Yuecheng Reservoir	51.2	0.3	0.19	0.5
Qingzhang Dongyuan water source area	103.5	0.1	0.14	0.25

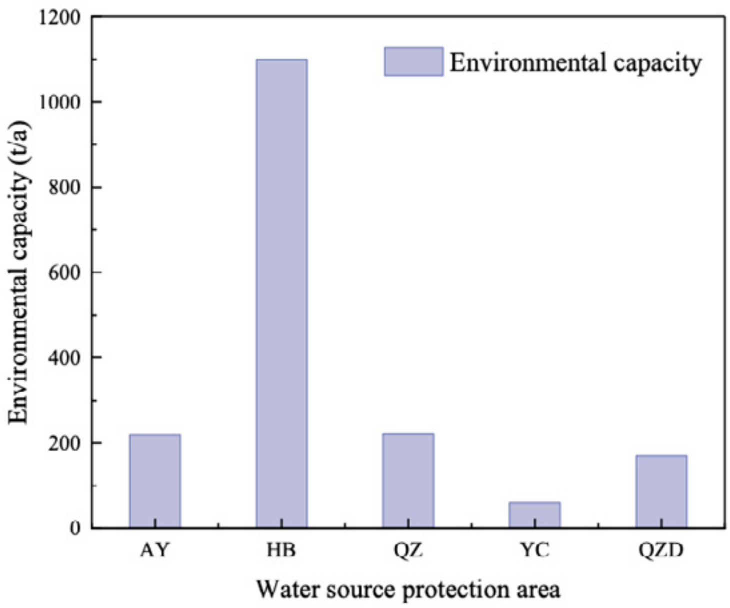

Figure 6. The environmental capacity of the main drinking water source protection area in the Zhangwei South Basin

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Figure 6 shows the COD emissions of pollutants in each water source area after the investigation and data collation, of which the emission of COD in the Yuecheng Reservoir Water Source Protection Area (YC) is the smallest, reaching only 98t/a, indicating that the water resources in the water source area are well protected, the emission of COD of Zhangwu Reservoir (AY) in Anyang City is 205t/a, the emission of COD in the North Water Source Area (QZ) of Qingzhanghe River is 208t/a, and the emission of Qingzhang Dongyuan Water Source Area (QZD) is 194t/a. The COD emission of the drinking water source area (HB) in the water source area of Hebi City was the largest, reaching 1088.1t/a, indicating that the water resources in the water source area were excessively wasted. Ecological problems are essentially environmental problems, and the accounting of ecological compensation standards should also be based on environmental cost accounting to promote the harmonious and unified development of social economy and natural ecology.

The treatment cost of major urban sewage treatment plants in China is 1.29 yuan / t, the COD concentration of inlet water is 253.79 mg / L, and the COD concentration of effluent is 22.03 mg / L. Bringing the data into the formula yields that the recovery cost P_0 is 100 million yuan/t.

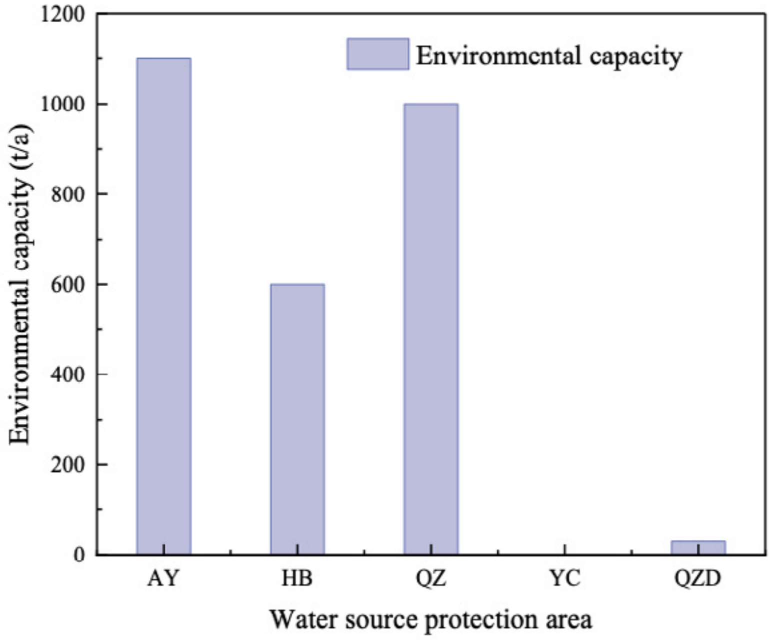

Figure 7. COD emissions by water source area

If the result is positive, that is, there is still a surplus of environmental capacity, the downstream should be compensated for the excellent water quality provided upstream; If the remaining environmental capacity is negative, that is, the upstream water does not meet the specified water quality standards, the downstream needs to carry out water ecological restoration measures to meet the water quality standards, so the upstream should compensate the downstream accordingly.

Among them, M is the water environment capacity of the functional area, the unit is mg, and M_0 is the total pollutant discharge. From the previous calculations, the

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recovery cost of water resources P_0 is 5.57×10^{-5} billion yuan /t, and the data is brought into Equation 11 to obtain the ecological compensation standard of each water source (a negative number indicates that the pollutant emission exceeds the water environment capacity, and the upstream pays the corresponding cost). The results are shown in Figure 8.

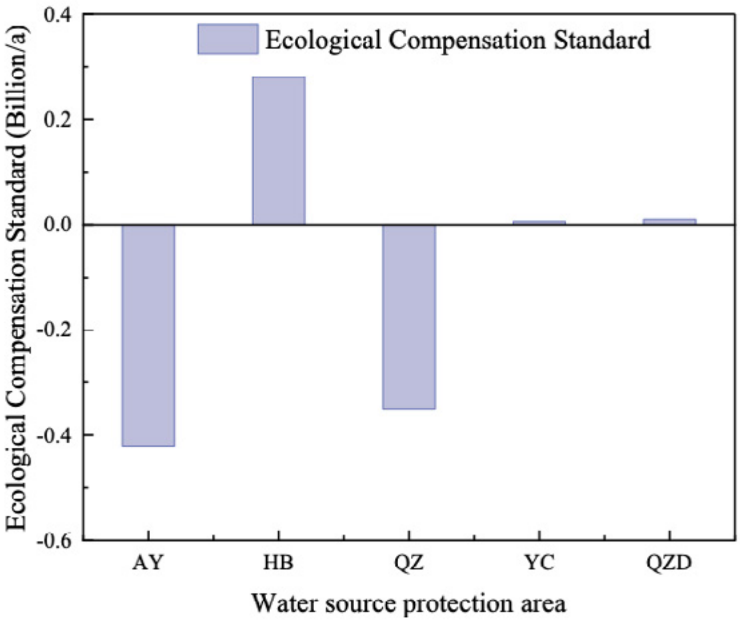

Figure 8. Ecological compensation standards for each water source area

The impact of polluting substances discharged by enterprises and units in Hebi City Drinking Water Source Area, Yuecheng Reservoir Water Source Area and Qingzhang Dongyuan Shanxi Conservation Area is within the scope of water environment capacity, and there is still a surplus water environment capacity, and the downstream upstream compensation is not necessarily used to compensate for the provision of excellent water quality, and the ecological compensation costs downstream to the upstream of Hebi Drinking Water Source Area, Yuecheng Reservoir Water Source Area and Qingzhang Dongyuan Shanxi Conservation Area are 282,310,000 yuan and 620,000 yuan /a, respectively.

According to the 2021 water environment monitoring of Anyang City, due to the discharge of a large amount of domestic sewage and industrial wastewater along the river, the water quality in the jurisdiction shows a deterioration trend of different degrees, and the water quality of the main rivers and reservoirs in Anyang City, the water quality of class II-III water that meets the national standard is very small, and the overall quality is poor. Combined with the research in this paper, the upstream drinking water source area of Zhangwu Reservoir in Anyang City needs to compensate 4.53 million yuan downstream for the implementation of measures such as downstream sewage treatment and water ecological restoration.

The demand for water for the socio-economic development of the Qingzhang River Basin is increasing, and industrial wastewater and urban domestic sewage are directly

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discharged into the river without treatment, resulting in river water pollution. The amount of water entering the upper reaches of the Qingzhang River has been greatly reduced, and the pollutants entering the river have greatly exceeded the pollution absorption capacity of the river, resulting in the serious deterioration of the water quality of the Qingzhang River, which has caused great hidden dangers to the safety of drinking water quality, and the implementation of ecological compensation measures, the upstream of the drinking water source area of the Qingzhang River in Hebei needs to compensate 3.88 million yuan downstream for water quality and water ecological restoration.

5. DISCUSSION

On the one hand, this paper empirically studies and designs the market-oriented ecological pollution compensation standards of China's industry. Its research paradigms and methods can provide useful reference and experience basis for further testing the common corporate pollution compensation standards at the micro level, especially in the future, when the environmental accounting information disclosure mechanism of listed companies in China is sound, it is more feasible. On the other hand, this paper takes the market-oriented ecological compensation standard of the upper and lower reaches of the Zhangwei South River Basin in China as a case for testing, but in fact, there is also an inter-provincial pollution compensation problem in the Boundary of Jiangsu, Zhejiang and Zhejiang and Shanghai in the Taihu Lake Basin, and the availability and length of the data are still to be studied. Of course, the research in this paper still needs to be deepened, for example: expanding pollutant indicators, which can incorporate pollutants issued by new national regulations such as PM2.5 into the atmospheric ecological pollution compensation standard system; broadening the compensation object, which can include the health and economic losses of residents in the downwind area of the industrial zone and the downstream of the river basin; exploring the compensation implementation mechanism, giving the existing compensation standards interval values, and introducing game mechanisms to lay a reliable foundation for the implementation of ecological and environmental pollution compensation in the future.

6. CONCLUSION

With the rapid development of the social economy, the continuous consumption of natural resources, and the increasingly prominent ecological and environmental problems, the awareness of the damaged people on ecological compensation has been further strengthened, requiring the adoption of reasonable ecological compensation standards to achieve sustainable social and economic development. To control and coordinate the relationship between economic benefits and environmental resources, realize the synchronous optimization of environmental benefits, social benefits and economic benefits, and promote the harmonious unity of economic development, social progress and environmental protection. In this paper, by designing ecological pollution compensation indicators and constructing a quantitative model, this paper discusses the principles, influencing factors, methods and calculation steps of the formulation of market-oriented ecological pollution compensation standards from the theoretical level. Through the panel regression model, an empirical study on the design of ecological pollution compensation standards in China's industrial industry and a case study on the design of compensation standards in the Zhangwei South River Basin were carried out. The conclusion is as follows:

1. From the perspective of new structural economics, the sub-regional nuclear density of fiscal decentralization is 0.722 in the eastern region, 0.468 in the central region, and 0.389 in the western region. The sub-regional nuclear density of the development strategy: 0.243 in the eastern region, 0.007 in the central region and 0.005 in the western region. This indicates that the higher the degree of fiscal decentralization, the higher the degree to which local development strategies will follow their comparative advantages.

2. According to the treatment cost of major urban sewage treatment plants in China is 1.29 yuan / t, the COD concentration of inlet water is 253.79 mg / L, and the COD concentration of effluent is 22.03 mg / L. The ecological compensation value of each water area is calculated. The comprehensive evaluation index of unit ecological environmental pollution will significantly cause damage to the real economy in the downwind area (downstream watershed), and the market-oriented ecological pollution compensation standard and compensation amount can be determined by the marginal cost of pollution.

3. The ecological compensation costs upstream of the drinking water source area of Hebi City, the water source area of Yuecheng Reservoir and the downstream of Qingzhang Dongyuan Shanxi Nature Reserve are 282,310,000 yuan and 620,000 yuan/a, respectively. The upstream of the drinking water source area of Zhangwu Reservoir in Anyang City needs to compensate 4.53 million yuan downstream for the implementation of measures such as downstream sewage treatment and water ecological restoration. The upstream of the drinking water source area of Qingzhanghe River Hebei needs to compensate 3.88 million yuan downstream for water quality and water ecological restoration.

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