Study on the Cost of Environmental Degradation

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***Abstract*—We propose an ecosystem service assessment model, Consider the problem from both the dominant and implicit environmental degradation costs.**
In order to obtain the cost of environmental degradation, we first use the factor analysis method to calculate the environmental pollution index of China's "three wastes" emissions from 2008 to 2017, and then use regression analysis and marginal analysis to analyze the environmental degradation costs caused by changes in environmental pollution indices. Secondly, we use the environmental pollution index as the explanatory variable, the explicit and implicit environmental degradation cost as the explanatory variables, and the industrial structure and per capita GDP level as the control factors to establish the regression model. Regression analysis using SPSS software can obtain correlation regression coefficients, and then analyze the correlation between environmental pollution index and environmental degradation cost. Finally, the environmental degradation cost is calculated by the absolute value of the environmental pollution index difference. It can be observed that the environmental degradation cost increases with time.

Keywords—linear regression; SPSS; dominant and implicit environmental degradation costs

I. INTRODUCTION

In recent years, the world's annual economic losses caused by environmental pollution and ecological damage are enormous. The idea and method of green GDP accounting play an important role in the measurement of environmental degradation costs. Ecosystem services, as a scientific study, date back to the mid-1960s. At the same time, it connects the fields of ecology, economics and sociology[1]. It is a cross-cutting frontier discipline that has developed rapidly in the late 20th century and has become a hot research topic.

Human economic activities, on the one hand, create wealth for society, On the other hand, human beings also discharge waste into the ecological environment through various production activities, or cut down resources to make the ecological environment worse. The general land development project does not matter to the overall operational capacity of the biosphere. However, it cumulatively directly affects the diversity of living things and leads to environmental degradation. A realistic assessment of the project's real economic costs can be achieved by establishing a sound ecosystem assessment model[2].

Based on the above materials, we recognize that the construction of new projects will cause serious damage to the ecological environment and directly affect the human living environment. Traditional land-use projects do not consider the impact of ecosystem services. We need to create a suitable ecological service assessment model to measure the cost of environmental degradation for projects of different sizes. And by considering the cost-benefit analysis of ecosystem services into land development projects, a true and comprehensive estimate of the project can be identified and evaluated. Based on, We need to address the following issues at the current level of research: Create an ecological service assessment model to reasonably estimate the environmental costs of land development and utilization projects and consider how to change over time.

II. ECOSYSTEM SERVICE ASSESSMENT MODEL

Land development and utilization projects will also bring about the loss of natural resources while bringing economic benefits. Resource depletion costs refer to the economic value of all natural resources consumed by the economic system during the accounting period. For the average enterprise, the value of such resource loss becomes the internal cost of the enterprise through market transactions and enters the product cost of the enterprise. The value of environmental degradation refers to the loss caused by natural ecological damage caused by the economic system during the accounting period. This loss creates an imbalance in the ecosystem that leads to environmental degradation. Therefore, the cost of environmental degradation should include both explicit and implicit environmental degradation costs[3].

A. Calculation of Environmental Pollution Level Index

The environmental pollution index is an abstract summary value that is summarized by various environmental quality parameters and comprehensively indicates the degree of environmental pollution or environmental quality. Because environmental pollution has the characteristics of time distribution and spatial distribution, a single environmental parameter can not reflect the real pollution situation, and it is difficult to compare environmental pollution of different time and space. therefore, The comprehensive index of environmental pollution index can not only objectively reflect the local environmental quality, but also compare the advantages and disadvantages of environmental pollution degree and environmental quality at different times and regions. Therefore, the environmental pollution index is widely used in environmental quality assessment.

B. Calculate the Environmental Pollution Index

For the measurement of the environmental pollution index, we count the number of "three wastes" (exhaust gas, waste water, fixed waste) of the industry from 2008 to 2017 from the official website of the China National Bureau of Statistics. Among them, the exhaust gas includes: exhaust gas (100 million cubic meters), sulfur dioxide (10,000 tons) of soot (10,000 tons), dust (10,000 tons); wastewater including wastewater (10,000 tons), mercury (tonnes), cadmium (tonnes), six prices Chromium (tonnes) lead (tonnes) arsenic (tonnes), volatile phenols (tonnes) cyanide (tonnes), chemical oxygen demand (tonnes), petroleum (tonnes), ammonia nitrogen (tonnes); solid waste in tons . Specifically, the "three wastes" were used as the measurement targets, and the SPSS software was used to weight the above indicators by factor analysis method, and the environmental pollution index for the 10 years from 2008 to 2017 was calculated[4].

III. Fitting of Factor Score Measurement Model

The factor analysis of the "three wastes" data from 2008 to 2012 was carried out, and two common factors were extracted, which were set to P1 and p2. According to the cumulative variance contribution rate of the factor analysis, the comprehensive score function can be derived as:

$$F = (80.958 \times P_1 + 14.554 \times P_2)/100$$

The final factor score results are as follows:

TABLE I. FACTOR SCORE TABLE

Years	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008
Factor 1 score	-1.506	-1.273	-0.678	-0.406	-0.184	0.073	0.541	0.806	1.152	1.476
Factor 2 score	-1.325	-1.025	0.766	0.913	0.913	1.137	0.859	-0.383	-0.792	-1.064
Composite factor score	-1.412	-1.180	-0.437	-0.196	-0.016	0.225	0.563	0.597	0.817	1.040

A. Measurement of Environmental Pollution Index

2008-2017 The results of the environmental pollution index for each year are based on the annual environmental pollution index factor score measurement model, and the high environmental pollution index for each year is measured. The results are as follows:

TABLE II. ENVIRONMENTAL POLLUTION INDEX

2017	2016	2015	2014	2013	2012	2011	2010	2009	2008
-1.412	-1.180	-0.437	-0.196	-0.016	0.225	0.563	0.597	0.817	1.040

It can be seen from the above table that as the year increases, the pollution index decreases in turn, and the environmental pollution index is positive after 2013, indicating that the environmental pollution level of "three wastes" has improved in recent years.

IV. Selection of Variables

Multivariate linear regression was used to analyze the correlation between environmental pollution index and the cost of dominant and implicit environmental degradation. The environmental pollution index of different types of projects is used as the explanatory variable, and the explicit and implicit environmental degradation costs of different types of projects are used as explanatory variables to analyze the correlation between environmental pollution index of various projects and the cost of explicit and implicit environmental degradation. Furthermore, the environmental costs are further measured from both explicit and implicit aspects[5].

V. Selection of Interpreted Variables

It is understood that in 2015, the Ministry of Environmental Protection launched the Green GDP 2.0 study, carried out environmental performance assessment, conducted economic green transformation policy research, explored environmental asset accounting and applied long-term mechanism, and calculated the environmental cost of economic and social development. The results of relevant report accounting show that the cost of environmental pollution caused by China's economic development continued to rise in 2006-2013, and the pressure of environmental pollution control is also increasing. Among them, the reported cost of ecological environment degradation accounts for about 3.9%-3.1% of GDP.

In this paper, the sum of hospitalization expenses for respiratory diseases and lung cancer in China from 2008 to 2017 was selected as an alternative index to measure the hidden environmental degradation cost caused by environmental pollution. The higher the level of environmental pollution, the higher the per capita hospitalization cost of patients with respiratory system and lung cancer, and the lower the national living standard.

VI. Control Variable Selection

Factors affecting the cost of environmental degradation include: industrial structure, per capita GDP level, national environmental investment, national infrastructure investment, total energy consumption and other factors[6]. The state of the country's industrial structure will have a direct impact on the environmental degradation costs of various industries. In addition, the GDP level of a country affects the level of environmental governance investment and the level of national medical expenditure. The national environmental management system and the national environmental protection investment also affect the investment of environmental pollution control. China's environmental management system, including the environmental protection target responsibility system, the "three simultaneous" system, etc., the three simultaneous systems have been considered by many researchers to the enterprise. Investment in energy conservation and emission reduction has an important impact. National infrastructure construction investment can reflect the actual strength of China's land development projects and better measure the environmental impact of each project. The total energy consumption can reflect

China's use of existing resources to measure the well-being of ecosystems. For related variables, see Table 3.

TABLE III. VARIABLE DEFINITION TABLE

Variable name		symbol	Description
Explained variable	Dominant environmental degradation cost	EX	Measured by China's various levels of environmental pollution control investment in each year of 2008-2017
	Implicit environmental degradation cost	IM	Measured by the total health expenditure in China in the years 2008-2017.
Explanatory variables	Environmental pollution index	k	Using analytic hierarchy process and cluster analysis method to calculate China's environmental pollution index in 2008-2017
Control variable	Industrial structure variable	Isv	Comprehensive measurement of the added value of China's three major industries in the 2008-2017 years
	Per capita GDP level	$PcGDP$	In terms of China's per capita GDP in the years 2008-2017
	National environmental investment	Nei	Measured by China's environmental protection expenditure in each year of 2008-2017
	National infrastructure investment	Nii	Measured by China's general public service expenditures in 2008-2017
	Total energy consumption	Tec	Measured by total domestic energy consumption in the years 2008-2017

VII. DESCRIPTIVE STATISTICS

TABLE IV. DESCRIBES THE STATISTICS

	N statistics	minimum statistics	maximum statistics	mean value statistics
V1	10	4937.03	9575.50	7935.2850
V2	10	14535.40	52598.28	31142.1770
V3	10	-1.41	1.04	.0001
V4	10	19473.47	62135.82	39077.4621
V5	10	24100.00	59201.00	41086.2000
V6	10	1451.36	5617.33	3383.7590
V7	10	9164.21	16510.36	12385.6810
V8	10	31898.00	55623.00	43468.9000
Valid N (list state)	10			

Note: The relevant data comes from the official website of China Statistics Bureau.

Indicator Description: V1 represents environmental pollution control investment V2 represents health total cost V3 represents environmental pollution index V4 represents three major industry added value V5 represents per capita GDP V6 represents national financial environmental protection pointed out that V7 represents national finance general public service V8 represents life Energy consumption

From the descriptive statistics of the variables in Table 4, the maximum environmental pollution index of each project is 1.04, which was generated in 2008, and the minimum value is -1.41, which was generated in 2017 with an average of .0001. Among the investment in environmental pollution control, the maximum value of 9575.50 was produced in 2014, and the minimum value was 493.733 billion yuan, which was born in 2008.

VIII. REGRESSION ANALYSIS

Two multivariate one-time regression equations were established to analyze the relationship between environmental pollution index and dominant environmental degradation cost and implicit environmental degradation cost in various grades, as shown in formula

$$EX = \beta_0 + \beta_1 k + \beta_2 Isv + \beta_3 PcGDP + \beta_4 Nei + \beta_5 Nii + \beta_6 Tec + \mu \quad (1)$$

$$IM = \beta_0 + \beta_1 k + \beta_2 Isv + \beta_3 PcGDP + \beta_4 Nei + \beta_5 Nii + \beta_6 Tec + \mu \quad (2)$$

In equations (1) and (2), β the regression parameters μ with estimated values are defined as random variables. Explicit and implicit environmental degradation costs are explained variables, environmental pollution index is used as an explanatory variable, and industrial structure variables, per capita GDP levels, national environmental investment, national infrastructure investment, and total energy consumption are used as control variables to conduct diversification. Linear regression analysis.

TABLE V. MULTIPLE LINEAR REGRESSION ANALYSIS

Explained variable	symbol	EX	IM
constant	Constant	-9033.585 (-0.412)	9033.585 (-0.412)
Explanatory variables	k	610.549 (0.063)	-611.549 (0.063)
Control variable	Isv	-0.067 (-0.035)	1.067 (-0.564)
	$PcGDP$	0.196 (0.156)	-0.196 (0.156)
	Nei	-1.978 (-0.422)	1.978 (-0.422)
	Nii	-0.572 (-0.96)	5.72 (-0.96)
	tec	0.582 (0.550)	0.582 (0.550)
R^2		0.954	0.999

$$EX = -9033.585 + 619.549k - 0.067Isv + 0.696PcGDP - 1.975Nei - 5.72Nii + 0.552Tec,$$

$$IM = 9033.585 - 611.549k + 1.067Isv - 0.696PcGDP + 1.975Nei + 5.72Nii - 0.582Tec$$

From the perspective of goodness of fit, the fitting effect of the two models is better, reaching more than 98%. The recessive environmental degradation cost regression equation explains the original information of more than 99% of the variables, indicating that the regression effect is better. The contrast coefficient shows that the cost of dominant and recessive environmental degradation is equivalent, and the regression equations of the two are basically the same.

IX. CALCULATE TOTAL ENVIRONMENTAL DEGRADATION COSTS

The differential method is used to calculate the total environmental degradation cost caused by changes in the pollution index of each pollution level project from 2008 to 2017. Based on this, the cost of dominant and implicit environmental degradation and its sum are calculated by calculating the changes in environmental pollution indices of various industries. The specific measurement methods are as follows:

First, the partial derivative obtained from the first-order partial derivative in the fitted regression equation is the dominant and implicit environmental degradation cost for each unit of the environmental pollution index from 2008 to 2017. The sum of the coefficients in the two regression equations is the cost of environmental degradation in 2008-2017 [5].

$$IE_U = \left|\frac{\partial(EX)}{\partial k}\right| + \left|\frac{\partial(IM)}{\partial k}\right| \tag{3}$$

In formula(3), IE_u the cost of environmental degradation caused by changes in the unit environmental pollution index.

Second: From 2008-2017, calculate the difference between the environmental pollution index of each year and the previous year, IE_u multiply and then sum and calculate the total cost of environmental degradation in various industries in 2008-2017, as shown in (4) Show:

$$IE_{T(2008-2017)} = \sum_{i=1}^{10}(IE_U \times \Delta PI_i). \tag{4}$$

In formula (4), $\mathrm{IE_T}$ it is the environmental degradation cost of various industries in 2008-2017. For the years 2003-2012, $\Delta \mathrm{k_i}$ the difference between the value of a certain year and the value of the previous year, that is, the annual environmental index,

If the above analysis is substituted into a specific value, you can get:

Measuring the 2008-2017 Environmental Degradation Cost Environmental Pollution Index for each unit increased, the total environmental degradation cost $\mathrm{IE_{(H)}}$ measurement process and results are as follows:

$$IE_U = \left|\frac{\partial(EX)}{\partial k}\right| + \left|\frac{\partial(IM)}{\partial k}\right| = 610.549 + 611.549 = 1222.098 \tag{5}$$

It can be seen from the above formula that for each unit of environmental pollution index, the cost of dominant and implicit environmental degradation is 610.549, 61.149 billion yuan, totaling 122.208 billion yuan. The environmental pollution index compared with the previous year from 2008 to 2017 is multiplied by the environmental degradation cost of the unit environmental pollution index by 122.208 billion yuan, and then aggregated to measure the total amount from 2008 to 2017. Cost of environmental degradation, as shown

$$IE_{T(2008-2017)} = \sum_{i=1}^{10}(IE_U \times \Delta k_i) = 32819.432. \tag{6}$$

In 2008-2017, due to the increase in environmental pollution, the total environmental degradation caused it was 32,819.432 billion yuan.

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