

Research on Environmental Performance Audit to Promote Balanced Development of Regional Economy in China

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Abstract - With the development of Chinese economy, both environmental problems and the unbalanced development of regional economy have been paid more attention. Environmental performance audit has then been put on the agenda and becomes a hot issue in the audit field. Based on the connection between regional economic and environmental development, this article reveals the current environmental situation of different provinces by selecting key indicators and also examines the effectiveness of environmental protection in the processing of regional economic development by using ecological efficiency index, through which some advice on environmental performance audit is provided for the regional economic entities.

Keywords - Regional economy; Environmental performance audit; Evaluation indicators

1. Introduction

The harmonious relationship between nature and human beings has been increasingly destroyed by globalization. As a responsible developing country, China faces a severe challenge of sustainable development.

Except for environmental problem, overpopulation and poverty which are common in developing countries, China also faces regional differences. Since China covers a vast geographic area, natural conditions and ecological environment in one province differ from that in the others. There are also many differences in economic structure and the level of economic development among different areas. While promoting regional development, we should pay equal attention to both developing economy and protecting the environment.

As the developing trend of environmental audit, environmental performance audit, which emerged in the late 1960s, has been taken more and more seriously. The academic have conducted many researches mainly including: (1) Causes of environmental performance audit;

(2) Legislation research on environmental

performance audit; (3) Main body of environmental performance audit; (4) Criterion of environmental performance audit research; (5) Procedures of the environmental performance audit; (6) the methods of environmental performance audit.^{[1][2]}

Environmental performance audit started late in China, which made some achievements, but there still exists a lot of shortage.^[3] The theory and legislation of environmental performance audit is imperfect.^[4] And the effectiveness is inconspicuous.^[5] Multiple factors have influences on the launching of regional environmental performance audit, such as economic development level, environmental protection input, comprehensive adjustment and the perfection of regulations.^[6]

To sum up, academia lacks of researches on environmental performance audit in combination with the balanced development of regional economy. Comparatively unified connotation of regional economic development hasn't been formed yet, neither has environmental index system suitable for economic development in most regions.^[7] Therefore, combining the current situation of economic development with

environment conditions in different Chinese provinces, the article conducted a research on regional environmental performance audit and provides some advice on promoting balanced development between regional economy and environment.

2. Comprehensive evaluation of economic development and environmental quality

The regional difference of natural environment is very numerous in different Chinese provinces, so are the level of economic development and environmental conditions. While evaluating economic development and environmental quality comprehensively in different Chinese provinces, we should establish corresponding index system to determine comprehensive evaluation model and analyze the final results of the model.^[8]

2.1 Indexes and methods of comprehensive evaluation

2.1.1 Selecting comprehensive evaluation index

According to the audit principle of systematic, independence, practicability, pertinence and maneuverability, the corresponding index system is established by PSR (pressure - state - response) concept model. Since both reasonably scientific index and the final evaluation suggestion are two most important steps in environmental performance audit, this paper evaluates natural conditions, ecological environment, resource condition and the level of economic development in different provinces. The specific index system is shown in Table 1.

Table 1. Regional comprehensive evaluation index system

Target	Top	Factors	Index
Comprehensive evaluation index system of regional economic development and the environment condition	Natural Index	Temperature	Average annual temperature (°C)
		Precipitation	Average annual precipitation
	Ecological index	Land	Land for farming (%)
			Land for construction purposes (%)
			Other (%)
		Forest and vegetation	Forest coverage rate (%)
		Pollution condition	Inhalable particles (PM ₁₀)
			Sulfur dioxide (SO ₂)
			Nitrogen dioxide (NO ₂)
			Days that air quality is or better than second level (day)
			Proportion of days that air quality is or better than second level in days the whole year (%)
	Resources index	Water resources	The total amount of water resources (cubic meters)
			Surface water resource
			Underground water resource
			Repeated measure of Surface water and underground water resources
			Per capita water resources quantity (cubic meters/person)
		Mineral resources	Oil (ten thousand tons)
			Natural gas (cubic meters)
			Coal (one hundred million tons)
	Economical index	Per capita GDP	Per capita GDP (Yuan)
		Rural income	Per capita net rural income (Yuan)

2.1.2 Realization of the comprehensive evaluation model

It is difficult to conduct evaluation directly after determining the comprehensive evaluation index, because the dimension among each coefficient isn't unified and without comparability. Therefore index data should be processed by standardization processing, namely range standard method. The formula is $y_{ij} = (x_{ij} - x_{\min}) / (x_{\max} - x_{\min})$, in which y_{ij} stands for

standardized value, x_{ij} stands for the actual value, x_{\max} and x_{\min} stand for maximum and minimum

value respectively. After standardization, $y_{ij} \in [0,1]$.

Next, entropy method is used to determine the weightiness of each index, the specific steps of which are as followings: (1) Defining f_{ij} as a proportion,

$f_{ij} = x_{ij} / \sum_{i=1}^n x_{ij}$; (2) e_i stands for the entropy value

of its index, $e_j = -k \sum_{i=1}^n f_{ij} (\ln f_{ij})$, $k = 1 / \ln n$; (3)

Calculating the weightiness of each index, of which the formula is $W_j = (1 - e_j) / \sum_{j=1}^m (1 - e_j)$; (4)

Establishing the comprehensive evaluation model,

$P_i = \sum_{j=1}^m W_j y_{ij}$, in which P_i stands for comprehensive

development level of each province, W_j stands for weightiness, and y_{ij} stands for standardized value.

The value P is between 0 and 1. The higher P is, the more comprehensively the province develops. $P=1$ is an ideal safe condition.

2.2 Analysis of the comprehensive evaluation results

The indexes of comprehensive evaluation results in 26 provinces (except for autonomous regions and special administrative regions) in China are computed with data in Chinese statistical yearbook, as is shown in Table 2.

Table 2. Comprehensive evaluation indexes in each province

Developed provinces							
Provinces	Beijing	Tianjin	Shanghai	Jiangsu	Zhejiang	Guangdong	
P	0.0942335	0.101037	0.1129294	0.1109552	0.1731545	0.2197633	
Less developed provinces							
Provinces	Hebei	Liaoning	Jilin	Heilongjiang	Anhui	Fujian	Jiangxi
P	0.1459395	0.1541159	0.1478812	0.2483949	0.1265307	0.1837419	0.2217211
Provinces	Shandong	Henan	Hubei	Hunan	Hainan	Chongqing	Sichuan
P	0.1753106	0.127002	0.1497061	0.1930564	0.1219351	0.1303229	0.3276783
Developing provinces							
Provinces	Shanxi	Guizhou	Shaanxi	Gansu	Qinghai	Yunnan	
P	0.1748808	0.1366124	0.2425829	0.1096821	0.1610925	0.2230851	

Data sources: calculated according to the Chinese statistical yearbook.

According to the data in Table 2, the comprehensive evaluation index is generally lower in developed provinces especially in Beijing, Tianjin and Shanghai. The three municipalities directly under the central government have much lower comprehensive evaluation index. While calculating the index, the weightiness

coming from entropy method is tend to be more natural resources and pollution condition, namely the weightiness of water resources, mineral resources and pollution index are higher than the others. Meanwhile, the weightiness of economic development level index is lower. That's why the comprehensive evaluation indexes

are lower in the three municipalities Beijing, Tianjin and Shanghai, which indicates that less storage of natural resources and industrialization contributes to higher pollution index in the rapidly processing of development. Thus the more developed a region is, the more reinforced supervision of environmental quality should be. One of the most effective methods is environmental performance audit. The differences of comprehensive evaluation indexes between less developed and developing provinces are much less obvious. Only Sichuan in less developed provinces has a higher comprehensive evaluation index, while Gansu in developing provinces has a lower one. It is relevant to natural environmental condition, resource reserve and pollution degree in both provinces. The reserve of natural resources is abundant in Sichuan, which isn't in Gansu located in loess plateau. This paper examines the effectiveness of environmental performance work by using the standard of ecological efficiency index in developed provinces. After comparing and analyzing the efficiencies of environmental protection work among developed provinces during the processing of development, some constructive suggestions are provided for environmental performance audit in order to promote the balanced development of regional economy.

3. Analysis on environmental performance audit in developed provinces

Economic externality brings about the deterioration of ecological environment increasingly. The general public becomes the most important victim, who takes the environmental cost of manufacturers but couldn't get any corresponding compensation. Thus people begin to take all kinds of measures to protect the environment benefit, of which the most important one is authorizing the

government as an agent to carry out the environmental management. Environmental protection work has not been officially listed in the economical responsibility audit category of leading cadres yet, but it is undisputed that governments at all levels are predominant in the environmental protection work. Evaluation of environmental protection effectiveness is needed when research on environmental performance audit is conducted in developed provinces.^[9]

3.1 Selecting evaluation index system for environmental performance audit

3.1.1 The goal of environmental performance audit

The audit goals are the guide to audit action, which is the ideal condition that audit needs to achieve. The determination of environmental performance audit objectives is helpful to providing basic foundation for environmental performance audit work. The objectives include three levels, namely basic objectives, specific objectives and sub-objectives, as is shown in Figure 1. Besides, environmental performance audit evaluation should also follow the principles of sustainable developmental, relevance, data availability and scientific, etc. The current environmental performance audit evaluation index system is not perfect. The existing index is consisted of environmental and economic index. Economic assessment index only pays more attention to economic growth, but ignores environmental protection and social responsibility. Environmental index only pays more attention to environmental benefits, neglecting economic benefits. Thereby this article selects the ecological efficiency index, combining economic indicators with environmental index properly.

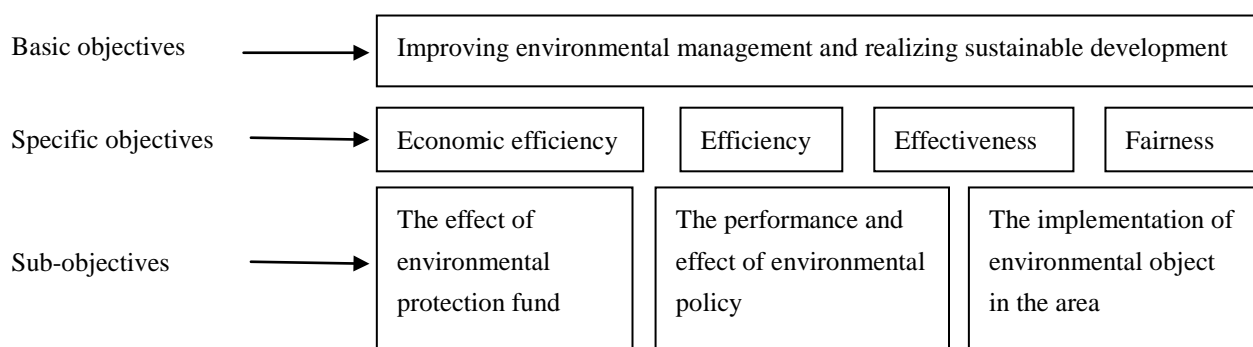


Figure 1. General flow chart of environmental performance audit

3.1.2 The establishment of ecological efficiency index system

The ecological efficiency indexes this article uses include economic development index and environmental performance indicators, in which energy consumption

reflects economic development index and industrial pollution controlling investment reflects environmental performance indicators. Ecological efficiency index (EPI) = economic development indicators or environmental performance indicators/gross domestic product (GDP). Ecological efficiency index system is shown in Table 3.

Table 3. Ecological efficiency index system

Economic development index	energy consumption
Industrial pollution control investment	Industrial pollution controlling investment
Ecological efficiency index (EPI) = economic development indicators or environmental performance indicators/gross domestic product (GDP)	

3.2 Analysis on differences of environmental protection effectiveness in developed provinces

The former ecological efficiency index of environmental performance evaluation index system is used to calculate the effectiveness of environmental

protection work in the processing of development in developed provinces in recent years. As what mentioned before, the results of computational process are as following Table 4, the data in which is chosen in statistic yearbook.

Table 4. Statistical indicators

Region	Year	2006	2007	2008	2009	2010
Beijing	GDP(hundred Yuan)	8117.78	9846.81	11115	12153.03	14113.58
	Energy consumption (ten thousand tons of standard coal)	5904	6285	6327	6570	6954.1
	Industrial pollution control investment (ten thousand Yuan)	108880.2	101397	78475	34421	19340
Tianjin	GDP(hundred Yuan)	4462.74	5252.76	6719.01	7521.85	9224.46
	Energy consumption (ten thousand tons of standard coal)	4500	4943	5364	5874	6818.08
	Industrial pollution control investment (ten thousand Yuan)	186315.5	149534	168270	180054	164684
Shanghai	GDP(hundred Yuan)	10572.24	12494.01	14069.86	15046.45	17165.98
	Energy consumption (ten thousand tons of standard coal)	8876	9670	10207	10367	11160.87
	Industrial pollution control investment (ten thousand Yuan)	87516.8	59269	103901	68357	94107
Jiangsu	GDP(hundred Yuan)	21742.05	26018.48	30981.98	34457.3	41425.48
	Energy consumption (ten thousand tons of standard coal)	19041	20948	22232	23709	25773.7
	Industrial pollution control investment (ten thousand Yuan)	389480.7	280053	397126	270554	185995
Zhejiang	GDP(hundred Yuan)	15718.47	18753.73	21462.69	22990.35	27722.31
	Energy consumption (ten thousand tons of standard coal)	13219	14524	15107	15567	16865.29
	Industrial pollution control	199470.4	250363	148007	193574	119568

	investment (ten thousand Yuan)					
Guangdong	GDP(hundred Yuan)	26587.76	31777.01	36796.71	39482.56	46013.06
	Energy consumption (ten thousand tons of standard coal)	19971	22217	23476	24654	27195.14
	Industrial pollution control investment (ten thousand Yuan)	370383.7	313708	403276	227464	310584

Data sources: Chinese statistical yearbooks.

As is shown as the above data, developed provinces maintained a relatively rapid economic development from 2006 to 2010. The corresponding energy consumption is also increasing year by year, which indicates that the local economy cannot bring about development without the consumption of energy.

Industrial pollution controlling investment presented an irregular trend, even appearing the trend of reduce year by year (Beijing). Thereby, environmental management in China still has obvious deficiency. The trend chart of ecological efficiency index is as Figure 2.

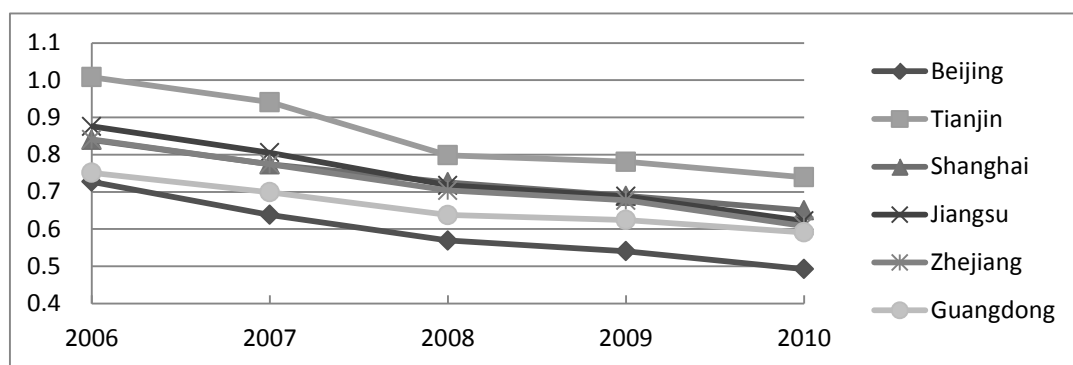


Figure 2. Ecological efficiency index-- energy consumption trend chart

Data resources: calculated according to former Table 4.

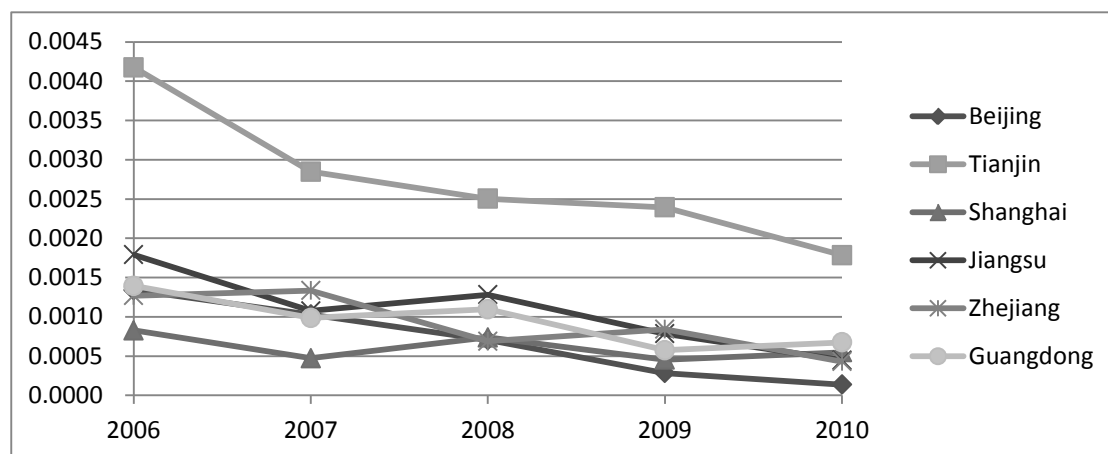


Figure 3. Ecological efficiency index - industrial pollution controlling investment trend chart

Data resources: calculated according to former Table 4.

According to Figure 3, energy consumption index and industrial pollution controlling investment index presented a trend of decline year by year on the whole in

developed provinces, especially Tianjin is the most significant one. It indicates that the environmental management and protection working has made some

achievements in developed provinces in recent years, but some obvious deficiency still exists. Since environmental performance audit system in China is not perfect, treatment after pollution model is often taken to conduct environmental protection. It is urgent to develop environmental performance audit.

The former comprehensive evaluation model has shown that ecological status indicators which reflects the pollution degree in the whole developed provinces, such as PM10, sulfur dioxide and nitrogen dioxide, have a trend of decline, but the trends of declining in most developed provinces are not so obvious except that several provinces have large extends of declination. In addition, the energy consumption indexes in developed provinces are increasing with the rising of GDP. It shows that the development of regional economy in developed provinces in China is actually at the cost of destruction of the environment quality and the high cost of natural resources. Although governments at all levels pay more and more attention to protecting the environment these years, but environmental protection investment is still not enough in practice. Despite the continuously rapid growth of GDP in the past five years, environmental protection investment was decreasing year by year. It indicates that we are consciously or unconsciously back to the past old path of high input, high consumption, high growth and low benefit in the processing of economic development.

4. Conclusions

4.1 Strengthening environmental performance audit work

The audit office of many provinces in China hasn't extend the environmental performance audit work yet, but there already exist some relevant theory discussion and compliance practice of environmental performance audit, such as environmental protection funds audit. Therefore, we should work on the existing basis thoroughly to carry out environmental performance audit, which is the urgent need of balanced development of regional economy, either. First, the current implementation of the environmental protection funds should be put into special audit work of environmental performance audit. In terms of the content of audit, environmental protection funds audit is an important part and indispensable foundation of auditing. Then, the

implementation audit of environmental investment, environmental laws, regulations, and policies should be strengthened. The audit can not only appraisal the environmental management and protection investment of units under audit, whether they observe and implement environmental laws, regulations and policies in the audit process, but also verify the governments' environmental policy regulation effect from another angle. Finally, efforts to strengthen augment and training of the audit team should be made to improve the professional accomplishments of audit personnel and reform the backward audit means. In order to adapt to the needs of the development of the regional economic equilibrium, audit institutions need to build a comprehensive, reasonable structure of audit talents. Government may master the first full and accurate and reliable material through the environmental performance audit, which provides reasonable basis and improve the feasibility of the decision for environmental supervision and decision-making.

4.2 Applying scientific environmental evaluation index system

The environmental performance audit doesn't have unified methods and technology. We should adopt the combination of qualitative analysis and quantitative methods to establish evaluation model and decide the index system and its weight reasonably when assessing the regional economic development. In the evaluation of the environmental performance audit activities, more authoritative ecological efficiency index in China is limited to basic theory introduction and the single variable environmental evaluation index is given priority, which has not been widely put into practice, so the existing quantitative appraisal index with single variable environmental evaluation index, such as PM10, SO₂ emissions, nitrogen dioxide emissions are given priorities. Double variable environmental evaluation indexes, such as energy consumption index and industrial pollution controlling investment index are also priorities. Compared with single variable index, double variable index is more scientific, but the environment variables and their associated costs and benefits are lack of contact, which can be solved by ecological efficiency index. Therefore, environmental performance audit provides accurate data and sufficient information by utilizing

necessary modern science and technology to enhance the authenticity and credibility of the evaluation results, which is committed to scientific reasonable decision in order to promote the balanced development of regional economy.

4.3 Improving the understanding of the effect of environmental input

In order to realize the goals of balanced development of regional economy and improving the environmental condition, we should first emphasize the effectiveness of environmental management and protection input. With the dropping of environmental protection investment proportion year by year, on the one hand, the government needs to increase the environmental protection investment and rely on scientific and technological progress to further reduce pollutant discharge in industrial wastewater emissions and industrial solid waste emissions, in order to improve water and soil quality, prompt people's living environment and improve the environmental quality. On the other hand, the government department should set up the concept of efficiency, improve the efficiency of policy implementation, and change the condition that some departments emphasize only on the implementation of policy but ignore the actual output after inputting natural resources. Therefore the government may introduce market concept and the private sector management skill to the administrative department. Finally, the government should mobilize human, material and financial resources to the largest extent, which we should make the best use of with fully rational methods. . Therefore, the environmental performance audit should also be introduced to the economic evaluation work in order to promote the balance of the regional economic development comprehensively.

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Vitae



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