

Research Article

Research on Application of Kendall W Coefficient in the Evaluation of Crop Environmental Cost Internalization

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Abstract: This study presents a method of evaluating the crop environmental cost of enterprise based on Kendall W coefficient. The Kendall W coefficient is used to analyze and evaluate the internal evaluation index of environmental cost. We selected some key enterprises of cleaner production auditing of Baoding city, Hebei province in 2014 as the research object and randomly selected nine enterprise cleaner production evaluation data, on the basis of using cleaner production evaluation method based on Kendall W coefficient on the state of enterprise cleaner production assessment analysis and exploration. The calculation results show that the introduction of Kendall W coefficient can improve the accuracy and scientific nature of enterprise's level evaluation of comprehensive analysis. It is an effective method for the evaluation of environmental cost internalization and it can provide scientific basis for the government to provide financial subsidies to enterprises with better crop environmental cost.

Keywords: Correlation analysis, crop environment cost, internalization of environment cost, Kendall W coefficient

INTRODUCTION

Along with the deepening of understanding on ecological environment, resources consumption and compensation (Chaabane *et al.*, 2012; Erol *et al.*, 2011; Avsar, 2008). People aware that in order to realize the sustainable development of human society, we must should give full consideration to the natural ecological environment in a variety of resources, energy consumption when carry out social and economic activities (Hong and Lifeng, 2013; Yingjuan and Lian, 2012; Kaiqin and Baixing, 2012). So we puts forward the concept of "environmental cost". At present, there is no uniform definition of "environmental cost". For ease of analysis, this study defined environmental cost as: all expense by the environmental pollution, destruction and resources loss which are brought by the product in the process of production and recycling (Zhang and Zhong, 2011; Büyüközkan and Berkol, 2011; Liu and Yang, 2007).

The produce of environment cost can be embodied in every aspect of human activity. The evaluation of the internalization of environment cost can be from human activity and requirement two aspects to consider. So we made a framework refer to activity pressure, reaction of an target analysis of environmental cost (Fig. 1).

Figure 1 it can be seen that the enterprise production and operation or consumer consumption

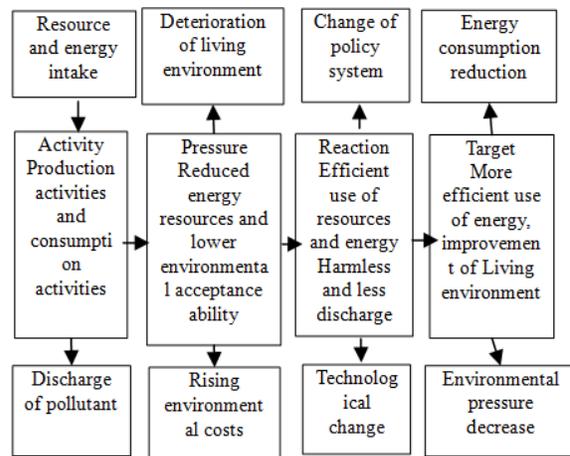


Fig. 1: Environmental cost analysis model

will cause environmental damage, loss of resources and result environmental management and repair costs. If these environmental costs borne by the producers and users of other social public, will inevitably lead to the low efficiency of environmental resources and cause serious impact on the sustainable development of environment, economy and society. Therefore, from the perspective of the scarcity of ecological resources, the government can through the development and implementation of environmental policies and the use

of government force or economic incentive mechanism, to take the external environmental costs produced by micro economic subject into their production or consumption decisions, so then realize internalization of environmental costs.

Environmental cost internalization refers to an enterprise that, by increasing environmental protection investment to reduce or even eliminate the environment pollution brought by enterprise product production, consumption and recycling link. Destruction and loss of resources, namely borne by the enterprise environment cost, part or all eliminate the original environmental costs shall be borne by the public, so as to reduce or eliminate pollution, protect the ecological environment of sustainable development. Once all environmental costs are included in the cost of the product, the product price reflects the whole social cost and the internalization of environmental costs is accomplished.

We can see from the environmental cost of produce process that the internalization of environment cost evaluation is a multi-index process and the result is a multi-index comprehensive evaluation index. However, due to the different index weights, the ranking of the enterprise's environmental cost based on the comprehensive evaluation index will be different. This study presents a method of evaluating the environmental cost of enterprise based on Kendall W coefficient. We take the key monitoring enterprise in Hebei province as the research object. Based on the evaluation method of the Kendall W coefficient we evaluate the internal level of enterprise environmental cost on the basis of the data of 9 randomly selected enterprises' environmental cost internalization.

This study presents a method of evaluating the crop environmental cost of enterprise based on Kendall W coefficient. The Kendall W coefficient is used to analyze and evaluate the internal evaluation index of environmental cost. We selected some key enterprises of cleaner production auditing of Baoding city, Hebei province in 2014 as the research object and randomly selected nine enterprise cleaner production evaluation data, on the basis of using cleaner production evaluation method based on Kendall W coefficient on the state of enterprise cleaner production assessment analysis and exploration. The calculation results show that the introduction of Kendall W coefficient can improve the accuracy and scientific nature of enterprise's level evaluation of comprehensive analysis. It is an effective method for the evaluation of environmental cost internalization and it can provide scientific basis for the government to provide financial subsidies to enterprises with better crop environmental cost.

THE CLEANER PRODUCTION EVALUATION METHOD BASED ON KENDALL W COEFFICIENT

Kendall W coefficient: Kendall W coefficient is to represent a method level variables related to the degree

of columns, is the index coefficient relation between characterization of two random variables or signals. It mainly analyzes the correlation and consistency of polyhedral evaluation conclusion problem, is a comprehensive analysis and evaluation on the various aspects and provides scientific basis for comprehensive evaluation. Kendall correlation coefficient applied to the amount of data has several related quantization values, which can be a plurality of data sequences to generate a plurality of the same system, also can be a plurality of data sequences repeatedly produced by the same system. The calculated Kendall correlation coefficient, can objectively evaluate the stability of the system and reliability of the data generated.

Kendall coefficient W the basic formula.

$$w = \frac{s}{\frac{1}{12} K^2 (N^3 - N)} \quad (1)$$

Among them, $s = \sum (R_i - \frac{\sum R_i}{N})^2 = \sum R_i^2 - \frac{(\sum R_i)^2}{N}$.

where,

N = The number of the object being rating (evaluation)

K = The number of equivalent PingDingZhe

R_i = Evaluation objects for the ith a level of K (quantity) sum

W's value, which indicates consistency or correlation of the evaluators's opinion, ranges from 0 to 1. If $W = 1$, all the k evaluators's opinion is the same. While it means the opinions don't consistent with each other completely if $0 < W < 1$. In other words, the opinions just have relevance to a certain extent. In this case, the bigger the value of W, the higher the consistency of the k evaluators's opinion. On the contrary, the smaller the value of W, the lower the consistency of the opinion. And if $W = 0$, the opinion doesn't relevant with each other at all.

However, there isn't one critical value of W which defines the consistency. Generally we can make judgment by comparison. In addition, con-sistency of group opinion with a big W is higher than the group opinion with a small W.

The environmental cost internalization evaluation system construction based on Kendall W coefficient:

To ensure that the evaluation of cleaner production levels just, comprehensive, democratic and scientific, it is necessary to establish cleaner production assessment system, generally including the environmental protection department inspection personnel, environmental protection department evaluation, cleaner production audit consultant evaluation and assessment consultancy industry experts.

The principle of the Comprehensive evaluation of enterprise environmental cost internalization. Are in

agreement in each link evaluation and rating, which fully reflects the views of the parties and the maximum degree of confidence the views of the parties.

We can use Kendall coefficient W in technology and according to the formula (1) is analyzed. Supposing that the comprehensive rating of the rating objects is a_i , then the correlation between all aspects of comprehensive rating and the rating consistency or available Kendall W coefficient to express:

$$w_0 = \frac{s_0}{\frac{1}{12}K^2(N^3 - N)} \quad (2)$$

Among them:

$$s_0 = \sum \left[R_i + a_i - \frac{\sum (R_i + a_i)^2}{N} \right]^2 = \sum (R_i + a_i)^2 - \frac{[\sum (R_i + a_i)]^2}{N}$$

The goal of comprehensive evaluation:

$$\max\{W_0(a_i)\} \quad (3)$$

Or,

$$\max\{s_0(a_i)\} \quad (4)$$

That is:

$$\max \left\{ s_0 = \sum (R_i + a_i)^2 - \frac{[\sum (R_i + a_i)]^2}{N} \right\} \quad (5)$$

Because the ratings are based on various aspects of evaluation to determine, The maximum possible value of W_0 , which is influenced and restricted by all aspects of rating and evaluation of consistency. In other words, the bigger w , the bigger the W_0 might be.

Therefore, the comprehensive evaluation, rating should make great value as much as possible. Supposing that there are many comprehensive evaluation scheme:

$$a_i^j, j = 1, 2, \dots, m,$$

Therefore, the comprehensive evaluation scheme which we choose should meet such conditions:

$$\max\{W_0(a_i^1), W_0(a_i^2), \dots, W_0(a_i^m)\} \quad (6)$$

Or,

$$\max\{s_0(a_i^1), s_0(a_i^2), \dots, s_0(a_i^m)\} \quad (7)$$

The corresponding solution j_0 .

If you consider a weight difference between evaluators, then you can introduce weight coefficient φ_i and:

Table 1: The evaluation results of the environmental cost internalization of key enterprises in Hebei province in 2014

Encoding	Acceptance	Self core	Industry evaluation	Agency experts
A	83	85	Good	Good
B	96	93	Excellent	Excellent
C	81	80	Medium	Good
D	86	84	Good	Excellent
E	84	83	Medium	Medium
F	86	89	Excellent	Good
G	82	82	Medium	Medium
H	94	95	Good	Excellent
I	84	86	Good	Excellent

Table 2: 2014 key enterprise environmental cost internalization preliminary comprehensive evaluation plan sort in Hebei province

Encoding	Comprehensive ranking				
	1	2	3	4	5
A	5	6	6	4	5
B	2	1	1	1	1
C	9	9	8	7	6
D	6	4	4	3	4
E	7	7	7	5	6
F	3	3	3	3	3
G	8	8	9	6	7
H	1	2	2	2	2
I	4	5	5	3	4

$$\sum_{i=1}^k \varphi_i = k \quad (8)$$

Then, formula (5) becomes:

$$\max \left\{ s_0 = \sum (R_i \varphi_i + a_i)^2 - \frac{[\sum (R_i \varphi_i + a_i)]^2}{N} \right\} \quad (9)$$

Using type (6)~(9) make a comprehensive analysis, the first thing to do is the calculation of φ_i . All aspects of the rating or comments may be qualitative, 100 score, five-point scale score or rating. In order to unified computing the sum of all aspects of evaluation grades, the sorting grade calculation method is adopted. All aspects of the evaluation rating is considered as the serial number of evaluation grades, which has the serial number of the same magnitude should be calculated using the average number. Comprehensive evaluation use the sort classification, when sorting is determined, then give score value according to the overall situation.

THE CASE DATA AND APPLICATION

Randomly selected nine companies in the list of 2014 years in Hebei province of key enterprises in cleaner production audit, their cleaner production audit the results of the various aspects as shown in Table 1, which called for a comprehensive evaluation according to the Kendall W coefficient method. Preliminary drawing up a comprehensive evaluation scheme as shown in Table 2. All the weight of

Table 3: Evaluation and evaluation scheme of the level of the program

Encoding	Acceptance score	Self evaluation	Industry expert	Agency	Compreh Ensive1	Compreh Ensive2	Compreh Ensive3	Compreh Ensive4	Compreh Ensive5
A	7	5	4.5	6	5	6	6	6	6
B	1	2	1.5	2.5	2	1	1	1	1
C	9	9	8	6	9	9	8	9	7.5
D	3.5	6	4.5	2.5	6	4	4	4	4.5
E	5.5	7	8	8.5	7	7	7	7	7.5
F	3.5	3	1.5	6	3	3	3	4	3
G	8	8	8	8.5	8	8	9	8	9
H	2	1	4.5	2.5	1	2	2	2	2
I	5.5	4s	4.5	2.5	4	5	5	4	4.5

Table 4: Comprehensive evaluation on environmental cost internalization level of key enterprises in 2014

Encoding	Internal level ranking	Comprehensive score	Note
A	6	86	
B	1	96	
C	8	82	
D	4	90	
E	7	84	
F	3	92	
G	9	80	
H	2	94	
I	5	88	

evaluation are 1 and according to the sorting grade calculation, then the results are shown in Table 3.

According to the data that in Table 3 analysis comprehensive ranking 1 and the relevance of all aspects of the evaluation, then according to formula (2) to calculate W_0 . The value of W in turn is 0.777, 0.789, 0.79, 0.785 and 0.787.

According to formula (6):

$$\max\{W_0(a_i^1), W_0(a_i^2), \dots, W_0(a_i^m)\} = \max\{0.79, 0.789, 0.777, 0.785, 0.787\} = 0.79$$

Therefore, the comprehensive ranking 1 is the most reasonable and evaluate all aspects of the highest consistency degree. So, comprehensive evaluation using the comprehensive evaluation of the 3 sorting. According to the highest 96, the lowest 80 to calculate, the results on Environmental cost internalization level of key monitored enterprises in 2014 that the key enterprises (Table 4).

CONCLUSION

This study presents a method of evaluating the crop environmental cost of enterprise based on Kendall W coefficient. Through research on the method of environmental cost internalization in Enterprises we can see that the introduction of Kendall W factor can enhance the cleaner production level evaluation of enterprises a comprehensive analysis of the accuracy and the scientific nature and the result is more reasonable. It can objectively reflect the cleaner production potential of emission reduction in size

from a certain extent. It can be seen from the case, Kendall W is very sensitive to the overall ranking, the authenticity can well reflect the effectiveness evaluation of cleaner production and to ensure consistency of comprehensive ranking and various aspects of the evaluation, the proposed method is reasonable and effective, so it is suitable for the enterprise of cleaner production level evaluation work. Therefore, cleaner production assessment method of Kendall based on W coefficient on the enterprise evaluation results, to provide scientific basis for the government to clean production effect better business of financial subsidies, in creating the role of enterprise cleaner production of external economic environment and development orientation to better play to the government policy, government policy and cleaner production to solve the correspondence measurement issues.

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