ISSN : 0974 - 7435 Volume 8 Issue 5

BioTechnology
An Indian Journal

FULL PAPER

BTAIJ, 8(5), 2013 [601-606]

Entropy weight fuzzy synthesis evaluation based on the measurement of environmental accounting

Li Liu
School of Business Administration, University of Science &Technology Liaoning, Anshan, 114051, (CHINA)
E-mail : db8089@163.com

ABSTRACT

In the environmental accounting elements, there are many fuzzy phenomenonÿthis paper provides a fuzzy synthesis evaluation model of entropy weight with the consideration of entropy theory. The related indicators are computed through fuzzy synthesis evaluation method and entropy theory, so the provided model can provide a help for the measurement of environmental accounting. Finally, the results of example prove the feasibility of this model in practice.

KEYWORDS

The measurement of environmental accounting;
Entropy;
Entropy weights;
Fuzzy synthesis evaluation.

INTRODUCTION

With the rapid development of modern industry, the material resources and the ecological environment has presented the growing signs of failure, so that the natural material foundation of the global economic development is moved. To solve this problem, some western scholars began to study on coordinated development of economic and environment since the 1970s, environmental accounting theory came into being. Environmental accounting began in the 1970s in the world, Beams (F.A.Beams) published an article of The social cost of pollution control conversion study on the Accounting Monthly in 1971; Marin (J.T. Marlin,) published an article of Accounting problems of pollution on the Accounting Monthly phase II in 1973. The accounting theory of western countries began to combine the environmental issues with accounting theory since that, and began the study of environmental accounting and environmental reporting, and formed a preliminary theoretical framework[1]. The measurement of environmental accounting is the process of recording economic business of environment as accounting elements formally and included in the accounting statements and determining its amount. There are many measurement methods for environmental accounting researchÿdomestic main views are: opportunity cost method, shadow price method and fuzzy mathematics method, the market value or productivity method, human capital or income loss method, protective cost method, the recovery cost or replacement cost method, environmental index conversion method, energy analysis and ecological footprint analysis, etc.[2]Xie Shi Fen (2004) research on environmental accounting measurement with the fair value; who thinks it is the most important method of measurement[3]. This paper on the basis of previous studies, the entropy optimization theory and fuzzy mathematics related theory are introduced into the environment accounting measurement,which provides a scientific and feasible method.

FULL PAPER

ENVIRONMENT ACCOUNTING THEORY

Environmental accounting is accounting theory and methods of recognition, measurement, revealing, analysis according to relevant environmental legislation and regulations. It uses monetary as the main units of measurement, it uses the specialized methods to confirm the gains and losses of social resources and environment caused by the enterprise, it provides environmental information for decision-makers.

The object of environmental accounting is the cycle that enterprises consume and compensate environmental resources constantly. Consume of environmental resource refers to the environmental pollution caused by the consumption of resources out of control, major accidents, waste discharge, loss of ecological deterioration, and the natural resources consumption over the fixed use caused by production, storage and transportation, and sales process of enterprise Compensation of environmental resources refers to the cost of environmental protection caused by the pollution control of enterprise, environmental improvement and sewage charges, fines and compensation submitted to the state or others[4].

The measurement of environmental accounting is the process of recording economic business of environment as accounting elements formally and included in the accounting statements and determining its amount. The measurement of environmental accounting can be used by following ways:

- The opportunity cost method. Because the net social benefit of some resources can not be directly estimated, so the opportunity cost of environmental resources is very useful to the economic benefits or economic loss to the measurement of environmental quality change. The land is an environmental assets, the value of the land may be measured by the opportunity cost method. For example, there are 4800 acres of land, the land of the original three quarters of crops,per acre net income of $350,there is an annual year-on-year rate of 2% of the output, discount rate is 10%, the net present value is 4.15 million in 24 years. If build the chemical plant, the net present value is 20 million in 24 years. Therefore, the opportunity cost of crops is 20 million; the opportunity cost of the chemical plant is 4.15 million.
- Shadow price method. Pricing idea of the shadow price is the marginal opportunity cost (MOC) of resource, all costs of consumption of a natural resource borne by the social, in theory, it should be the price P paid by users for their behavior, P = MOC. When P < MOC, it will stimulate the excessive use of resources, when P> MOC, it will inhibit the normal consumption. Shadow prices remedy the defect of the traditional resource economics that ignore the environmental costs of resource or the interests of victims and future generations, it can be as effective decision-making criterion used to identify weather relevant resources and environmental protection policies and measures are reasonable.
- Fuzzy mathematics method. Fuzzy mathematics is a branch of mathematics based on fuzzy. The value of environmental resources system is a complex system, it is a system that natural and economic and social interact and influence each other. When the complexity of the system increases, the accurate ability to reduce. When it comes to a certain extent, the complexity and accuracy are mutually exclusive, so we are here to solve the problem of environmental accounting measurement with a fuzzy concept. For example, there are a lot of fuzzy things in the measurement of the value of water resources; it can be measured by fuzzy mathematics method. Let A be the factors of water resources value, A = (A1, A2, A3, A4). Among them, the A1: water quality; A2: The quantity of water; A3: The population density; A4: national income. Q is the evaluation vector, Q = (high, higher, general, lower, and low). K is the evaluation matrix. $Q = A \times K$. S is the price vector of the water resources. V is the price of water, $V = Q \times S$, therefore, $V = A \times K \times S$. Thus the price of water resources can be calculated.

ENTROPY WEIGHT FUZZY SYNTHESIS EVALUATION MODEL

Calculation of entropy weight

"Entropy" originated in Greek "$\tau PO\pi\eta$ ", means the capacity of the change. In 1856, German physicists

R.Clausius introduced the entropy concept into thermodynamics, and soon got recognition of thermodynamics and statistical mechanics experts, and then this theory was applied to the wider fields.

There is a probability experiment which may be has many independent results as $a_1, a_2, \cdots, a_n$, and we suppose these results are the discrete probability as $p_1, p_2, \cdots, p_n$, they meet probability rationality formula:

$$\sum_{i=1}^{n} p_i = 1 \text{ and } p_i \geq 0 (i = 1,2,\cdots,n) \quad (1)$$

The discrete information entropy function can be expressed as formula:

$$S = -\sum_{i=1}^{n} p_i \ln p_i \quad (2)$$

The entropy of factor can be calculated by using formula (2), assuming there is a matrix (M_{ij}), the calculation steps are shown such as formula (3) - formula (6):

1) We can compute the weight of the first j indexes m_{ij} in the index, namely

$$p_{ij}, p_{ij} = m_{ij} \Big/ \sum_{i=1}^{n} m_{ij} \quad (3)$$

2) We can compute the entropy of the first j indexes, namely

$$S_j = -k \sum_{i=1}^{n} p_{ij} \ln p_{ij} \quad (4)$$

3)We can compute the deviation degree of the first j indexes, namely

$$d_j = 1 - S_j (j = 1,2,\cdots,n) \quad (5)$$

4)We can compute the entropy weight of the first j indexes, namely

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j} = \frac{(1 - S_j)}{\sum_{j=1}^{n} (1 - S_j)}, (j = 1,2,\cdots,n) \quad (6)$$

Through the above steps, we can find out the corresponding entropy weight, it can provide data support for the fuzzy synthesis evaluation method[5].

Fuzzy sets theory

The fuzzy sets theory was put forward by the automatic control experts Chad (L.A.Zadeh) in the information and control in 1965, which was used to represent the uncertainty of things. Fuzzy synthesis evaluation method was a kind of synthesis evaluation method based on the fuzzy mathematics; the synthesis evaluation method transformed the qualitative evaluation into quantitative evaluation on the basis of fuzzy membership degree theory, which used fuzzy mathematics to make an overall evaluation to things or object restricted by various factors.

Definition 1 Membership Function

Suppose there is a theory field

$$U \text{ ,if } \mu_A(X) : U \to [0,1] \quad (7)$$

Then it says that $\mu_A(X)$ is membership degree of $X \in A$, thus $\mu_A(X)$ is membership function of A.

Definition 2 Fuzzy Synthetic Operator

We can get fuzzy matrix according to the fuzzy synthesis evaluation, the calculation such as formula (8):

$$S = W \circ R = [\mu_1 \quad \mu_2 \quad \mu_3 \quad \mu_4] \circ \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} = [S_1 \quad S_2 \quad \cdots \quad S_N] \quad (8)$$

Among, $W, W = [\mu_1 \quad \mu_2 \quad \cdots \quad \mu_N]$ is theory field of evaluated objects; r_{ij} expressed as fuzzy relation matrix of secondary index for each comment set; "$\circ$" is fuzzy synthetic operator, there are four calculation ways, features such as TABLE 1:

TABLE 1 : Respective expression for four kinds of synthetic operator

Feature	Operator			
	$M(\wedge,\vee)$	$M(\bullet,\vee)$	$M(\wedge,\oplus)$	$M(\bullet,\oplus)$
Information by using R	Not fully	Not fully	More fully	Fully
Function of weight	Not obvious	Obvious	Not obvious	Obvious
Synthesis degree	Weaker	Weaker	Strong	Strong
Type	Main factors outstanding type	Main factors outstanding type	Weighted average type	Weighted average type

FULL PAPER

In TABLE 1, the calculation of various operators as follows:

$$M(\wedge,\vee)=\max_{1\le j\le m}\{\min(\mu_j,r_{jk})\},k=1,2,\cdots,n;$$

$$M(\bullet,\vee)=\max_{1\le j\le m}\{u_j\cdot r_{jk}\},k=1,2,\cdots,n;$$

$$M(\wedge,\oplus)=\min\{1,\sum_{j=1}^{m}\min(\mu_j,r_{jk})\},k=1,2,\cdots,n;$$

$$M(\bullet,\oplus)=\min\{1,\sum_{j=1}^{m}\mu_j r_{jk}\},k=1,2,\cdots,n$$

From TABLE 1, it is known that this paper will select operator $M(\bullet,\oplus)$ to calculate in considering the influence of the main factors and other factors[6].

4 Establishment of Water Resources Price Model

On the basis of entropy rule of optimization and fuzzy mathematical correlation theory, the water resources price model are constructed as follows:

1) To determine the theory field A of the water resources factors value, then one class index is expressed as $A_i: A=(A_1,A_2,A_3,A_4)$, secondary index is expressed as $A_{ij}: A_{ij}=(A_{i1},A_{i2},\cdots,A_{ij})$, as shown in figure 4.1:
2) At the same time, according to the expert scoring method we can determine the weight vector of the evaluation factors: Among, the weight vector of layer A_i to layer is A, $a=(a_1,a_2,a_3,a_4)$the weight vector of layer A_{ij} to layer A_i is $bi=(b_1,b_2,b_3,b_4)$;
3) We can determine the comment grade theory field , and assignment for every comment set elements; so as to construct the fuzzy relation matrix of the secondary index A_{ij} for each comment set, the fuzzy relation matrix is $R: R=(r_{ij})_{i*j}$, among, r_{ij} is the degree of membership of the elements A_i to elements V_j;
4) According to one class index fuzzy set $C_i(C_i=b_i\times R_i)$, we can get a new fuzzy synthesis evaluation matrix $M_{ij}=(m_{i1},\cdots m_{ij})$, among, the calculation of C_i on the basis of fuzzy operator $M(\bullet,\oplus)$;
5) By means of entropy weights method, the synthesis weight vector is obtained as $W: W=W_j a_i/\sum_{i=1}^{n}W_j a_i$;
6) We can calculate the fuzzy synthesis evaluation value: $p=W\times M^T$, and normalized processing ,then we get $\hat{p}_i(\hat{p}_i=P_i/\sum_{i=1}^{n}P_i)$;
7) We can get new evaluation matrix K with the revaluation to the above indexes, then the corresponding water resources evaluation vector is Q,and so $Q=A*K$;
8) In the calculation of the price of water resources, it is necessary to set up a water resources price ceiling, combined with anshan actual residents consumption and related economic indicators, the water resources price ceiling can be expressed as $P=B*E/C-D$:

Among, P is water resources price ceiling, B is maximum water bear index,

This article selects B=0.006, E is actual income per capita, is monthly water consumption per capita, C is water supply cost and normal profit.

9) According to (7),(8), if you assume that V is the price of water resources, S is water resources price vector, then the price of water resources can be written

$$V=\hat{p}_i*Q*S$$

Among, the calculation of is on the basis of, at the same time use arithmetic interval, we can get water resources price vector.

EMPIRICAL ANALYSIS

Based on the entropy weight fuzzy synthesis evaluation system of the above the water resources price, we can calculate the water resources reasonable price of anshan city in liaoning province. Based on data of anshan water resources department, monthly actual income per capita of anshan in 2011 is 1774.81 yuan, monthly water consumption per capita is 3.08 tons, water supply cost and normal profit is 1.8 yuan/ton, then:

1) The theory field of the water resources factors value can be expressed as figure 1;
2) According to the expert scoring method we can determine the weight vector of the evaluation factors: among, the weight vector of layer A_i to layer A is $a=[0.4\quad 0.3\quad 0.2\quad 0.1]$, the weight vectors of layer A_{ij} to layer A_i are $b_1=[0.3\quad 0.3\quad 0.2\quad 0.2]$, $b_2=[0.3\quad 0.7]$, $b_3=[1]$, $b_4=[0.6\quad 0.4]$
3) We can construct the fuzzy relation matrix of the

secondary index A_{ij} for each comment set, the fuzzy relation matrix is $R: R = (r_{ij})_{i*j}$, and so we can obtain the following matrix:

$$R_1 = \begin{bmatrix} 0.4 & 0.2 & 0.3 & 0.1 & 0.0 \\ 0.3 & 0.3 & 0.2 & 0.1 & 0.1 \\ 0.2 & 0.2 & 0.2 & 0.1 & 0.2 \\ 0.3 & 0.1 & 0.1 & 0.2 & 0.3 \end{bmatrix};$$

$$R_2 = \begin{bmatrix} 0.3 & 0.2 & 0.1 & 0.3 & 0.1 \\ 0.3 & 0.3 & 0.2 & 0.1 & 0.1 \end{bmatrix};$$

$$R_3 = [0.3 \quad 0.2 \quad 0.2 \quad 0.2 \quad 0.1];$$

$$R_4 = \begin{bmatrix} 0.2 & 0.3 & 0.1 & 0.2 & 0.2 \\ 0.1 & 0.3 & 0.2 & 0.2 & 0.2 \end{bmatrix};$$

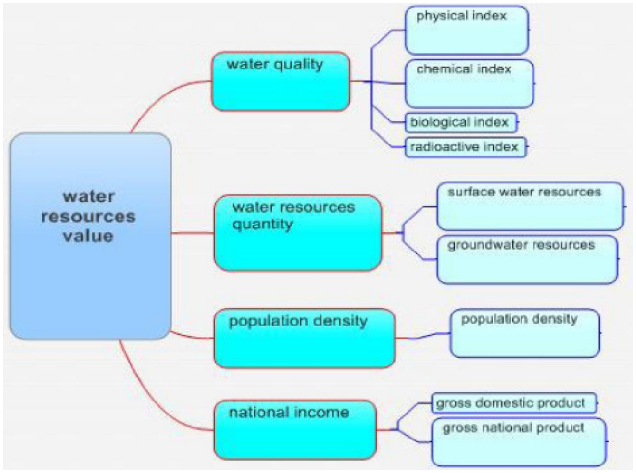

Figure 1 : Water resource value factors

4) According to the fuzzy operator calculation we can get a new fuzzy synthesis evaluation matrix $M_{ij} = (m_{i1}, \cdots m_{ij})$:

$$M = \begin{bmatrix} 0.31 & 0.21 & 0.21 & 0.12 & 0.13 \\ 0.30 & 0.27 & 0.17 & 0.16 & 0.10 \\ 0.30 & 0.20 & 0.20 & 0.20 & 0.10 \\ 0.16 & 0.30 & 0.14 & 0.20 & 0.20 \end{bmatrix}$$

5) By means of entropy weights method, the synthesis weight vector is obtained as $W = [0.398 \quad 0.280 \quad 0.208 \quad 0.114]$

6) We can calculate the fuzzy synthesis evaluation value and get $p = [0.288 \quad 0.235 \quad 0.189 \quad 0.157 \quad 0.123]$, and normalized processing P, then we get $\hat{p}_i = [0.290 \quad 0.237 \quad 0.191 \quad 0.158 \quad 0.124]$;

7) The corresponding water resources evaluation vector can be written as:

$$Q = \begin{bmatrix} 0.4 & 0.3 & 0.1 & 0.1 & 0.1 \\ 0.3 & 0.2 & 0.2 & 0.1 & 0.2 \\ 0.2 & 0.1 & 0.2 & 0.3 & 0.2 \\ 0.2 & 0.2 & 0.3 & 0.2 & 0.1 \\ 0.3 & 0.1 & 0.1 & 0.2 & 0.3 \end{bmatrix}$$

8) According to the existing data, the water resources price ceiling of anshan can be calculated as:

$$P = B * E / C - D = 0.006 * 1774.81/3.08 - 1.8 = 1.66$$

9) Then S is water resources price vector, by using arithmetic interval, we can get $S = [1.66 \quad 1.25 \quad 0.83 \quad 0.42 \quad 0]$, and then the price of water resources can be written as:

$$V = \hat{p}_i * Q * S = 0.95 \text{(yuan/cubic meters)}$$

If considering water supply cost and other related factors, water price of anshan can pricing for 0.95 + 1.8 = 2.75 (yuan/cubic meters).

CONCLUSIONS

In the entropy weight fuzzy synthesis evaluation model, by using the entropy optimization function we can determine the weight vector of each layer factors objectively, and evaluate with fuzzy synthesis evaluation according to the weight vector. According to the entropy and entropy weight, the price of water resource can be concluded, so the fuzzy synthesis evaluation model is feasible in the environment accounting elements measurement which based on the entropy weight. From essence of entropy function and fuzzy mathematics theory to see, it is to measure the degree of uncertainty. So it avoids the difficulty of qualitative analysis, and associates better the qualitative problem with quantitative problem by combining them and applying to the model. The considering factors of entropy weight fuzzy synthesis evaluation model consider for cable are comprehensive, compared with the traditional accounting measurement method. This method overcomes the limitations of traditional accounting measurement method. This method is verified to be reasonable by means of example and it can provide an objective basis for environment accounting measurement.

REFERENCES

[1] Bartelmus, Peter; Accounting for Sustainable De-

velopment Working Paper 8. New York: United Nations, Department of International Economic and Social Affairs.——1987b. "Beyond GDP: New Approaches to Applied Statistics the Review of Income and Wealth, **33(4)**, 347-58 (December) **(1987a)**.

[2] Sun xing hua.Wang zhao rui; Green accounting measurement and report. Accounting Research. (in Chinese), **(3)**, 54-57 **(2002)**.

[3] Xie shi fen; Fair value measurement: China into green GDP concept and the important premise of environment accounting audit. The Theory and Practice of Finance and Economics. (in Chinese), **(1)**, 72-76 **(2004)**.

[4] Zhang si chun. Sun xing hua; Discussion of measurement of environmental accounting. Friends of Accounting. (in Chinese), **(1)**, 22-23 **(2008)**.

[5] C.E.Shannon; The Mathematical Theory of Communication. Bell Sys.Tech.J., **(27)**; 279~428, 623~656 **(1948)**.

[6] L.A.Zadeh. Fuzzy Sets; Information and Control, **8**, 338~353 **(1965)**.