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EVALUATING COMPETITIVE EDGE FOR LOGISTICS ENTERPRISES BASED ON BP NEURAL NETWORK

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ABSTRACT

Evaluating competitive edges plays a key role for logistics enterprises and it is one of the difficulties and hot research fields for the researchers related. The paper presents a new model for evaluating competitive edges of logistics enterprises based on the principle of value network and improved BP neural network. First an evaluation indicator system of competitive edges of logistics enterprises is designed through analyzing the characteristics of the evaluation indicator with more details; Second, Legendre wavelet is used to speed up the convergence of BP neural network algorithm and based on this the paper advances a new competitive edge evaluation model for logistics enterprises. Finally, four Chinese logistics enterprises are taken for examples to verify the validity and feasibility of the model and the experimental results show that the model can evaluate the competitive edges of logistics enterprises practically and can help the logistics enterprises to take concrete measures to enhance its competitive edge.

Keywords: *Competitive Edge Evaluation, Value Network, BP Neural Network, Legendre Wavelet*

1. INTRODUCTION

Traditional principle of value chain gives a good explanation that the competitive edge of enterprises comes from certain specific value activities on the value chain of enterprises. Enterprises are able to obtain competitiveness with these specific parts under control and mastery. However, with the change of competitive environment of information era, it is not enough for enterprises only focusing on self specific value activities, logistics enterprises also need to pay attention to the overall efficiency of value system of the entire industry.

Value network brings logistics enterprises into modern network environment, which makes logistics enterprises satisfy the unique needs of customers and seek for the development opportunity for enterprises in these unique needs. In the value network of logistics enterprises, taking customers' needs as starting point, focusing on the individual and diversified needs of customers as well as the close cooperation among strategic partners, competitors and other organizations, through the complicated dynamic network communication among them, jointly realize various kinds of businesses increasing value for customers, meanwhile, each party will make a profit, thus forming a multi-win-win pattern. Through this win-win value-creating network, logistics enterprises can make the core competence of other network members create value for logistics enterprises' ultimate customers. Therefore, the study of the competitive edge of logistics enterprises based on the principle of value network has become one of the study focuses in the industry[1].

2. LITERATURE REVIEW

2.1 Review of Logistics enterprises Edge Evaluation Indicators Design

Application Status of Foreign Study: Foreign research scholars have carried out a relatively deep research on the competitiveness of logistics enterprises, ① the study of Vivas Ana Lozano (1997) [1]on Logistics Enterprises breaks through the simple comparison by performance indicators, adding the comparison in aspects of system, technology and environment; ② Haaf Katharina (2002), Swierezek Fredric William, Shrestha Pritam K (2010) [2] carry out competitiveness study of different regions and logistics enterprises, respectively put forward the reasons for competitiveness differences among logistics enterprises, playing a guiding role in correctly recognizing and cultivating competitive capacity of logistics enterprises as well as creating competitive edge. ③ CAMELS, which takes capital adequacy ratio, asset quality, management ability, income and profitability, liquidity and sensitivity to market risks as major evaluation indicators, is the evaluation system on Logistics Enterprises widely used by foreign major financial regulators and international financial analysts[3,4,5].

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2.2 Review of Logistics Enterprise Edge Evaluation Methods

At present, the evaluation methods of enterprises competitiveness at home and abroad are mainly the following four categories. ① AHP [6,7] (Analytic Hierarchy Process), a practical multi-scheme or multi-target decision making method, first makes the problem to be analyzed hierarchical, divides the problem into different components according to the nature of the problem and total target to be achieved, composes the components in different hierarchies according to correlations and subordinations among components, forming a multi-hierarchy analysis and evaluation structure model; ② TOPSIS [7] (Technique for Order Preference Similarity to Ideal Solution) ranks the order of solutions according to each appraised scheme and the distance between ideal solution and negative ideal solution. Ideal solution is the best solution assumed, each attribute value of which reaches the optimal value among all the appraised schemes. Negative ideal solution is the worst solution assumed, each attribute value of which is the worst value among all the appraised schemes. While conducting overall evaluation, the overall situation of appraised object is always reflected by confirming indicators at all hierarchies. ③ Factor analysis is a multi-variable statistical analysis technique that starting from the study on dependence among correlation matrix, some variables with complicated relations come down to a few comprehensive factors. Factor analysis among variables (r-type factor analysis) is the promotion of principal component analysis, the basic idea of which is to group variables according to the size of correlation, so as to obtain a relatively high correlation among variables in the same group; but variables in different groups have low correlation, every group of variables represent a basic structure—common factor. ④ DEA[7] (Data Envelopment Analysis) is a new method for statistic analysis. From the perspective of production function, the model is used for the study of "production department" with multiple inputs, especially with multiple outputs, also, system evaluation deemed as "Scale Efficiency" and "Technical Efficiency" is a very ideal and effective method; ⑤ Recently BP neural network is used wildly in the field for its high evaluation accuracy, but it need long tome to converge of the calculation when BP neural network is used in competitive edges evaluation in practice which limits the uses of the BP neural network[8,9].

Based on BP neural network , Legendre wavelets neural network is being constructed with Legendre wavelets in this paper. In so doing, not only the problem of convergence speed has been solved, but also the simplicity of the model structure and the accuracy of the transformation are ensured.

3. EVALUATION INDICATORS DESIGN

Logistics enterprises is a complicated comprehensive operation system constituted by multiple elements, the numerous elements and subsystems of which exist in different forms, jointly assembly and forming competitiveness. This paper, based on the principle value network, in the light of connotation characteristics of competitiveness evaluation of logistics enterprises, especially on the basis of competitiveness analysis of Logistics Enterprises and experts consultations, combined with literatures, establishes a wide and scientific evaluation indicator system of logistics enterprises [4,5,6,7], which includes four hierarchies, three categories, 6 second-grade indicator, 25 third-grade indicator. The target hierarchy of the system is competitiveness of logistics enterprises which includes three first-grade indicators, namely resource elements (including two second-grade indicators, namely material resource and human resource), capability elements (including two second-grade indicators, namely management capability and product capability), environmental elements (including two second-grade indicators, namely regular customer and social economic environment). Material resource includes seven third-grade indicators, namely non-performing asset ratio, capital liquidity ratio, capital scale, capital scale growth rate, profit growth rate, information resources ownership, logistics enterprise scale (number of branches etc.); Human resource includes three third-grade indicators, namely total staff, professional and technical talents, core management layer, Management capability includes three third-grade indicators, namely management layer competence, organization operation capability, technology application ability; product capability includes four third-grade indicators, namely product development, marketing, product processing, customer service; Regular customer includes three third-grade indicators, namely cooperation with securities industry, cooperation with insurance industry, cooperation with other large-scale enterprises; Social economic environment includes five third-grade indicators, namely local economic environment, monetary policy, macroeconomic control, financial operation environment, development of related industries.

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4. EVALUATION MODEL DESIGN

4.1 Legendre Wavelets Neural Network

Wavelets can provide multi-resolution proximity for function differentiation as well as localization of space and frequency. Therefore, wavelets neural network based on wavelets analysis theory is more adaptable to learn locally non-linear and rapidly changing functions. Legendre wavelets is Formula1, in which m , the order of Legendre polynomial and t , the time, are defined in the interval $[0,1)$ to satisfy Formula 2. In Formula 2, $L_m(t)$ is the Legendre polynomial, in which $L_0(t)=1$、$L_1(t)=t$ and the others satisfy the Recursion Formula 3. It can be proved that for different values of n , Legendre wavelets remain orthonormal.

$$\psi_{nm}(t)=\psi(k,\hat{n},m,t),\quad k=2,3...,\quad \hat{n}=2n-1,\quad n=1,2..2^{k-1} \tag{1}$$

$$\psi_{nm}(t)=\begin{cases}[m+\frac{1}{2}]^{1/2}2k/2L_m(2^k t-\hat{n}), & \frac{\hat{n}-1}{2^k}\le t\le\frac{\hat{n}+1}{2^k}\\ 0 & others\end{cases} \tag{2}$$

$$L_{m+1}(t)=\frac{2m+1}{m+1}tL_m(t)-\frac{m}{m+1}L_{m-1}(t) \tag{3}$$

From Formula 3, it can be known that a function $f(t)$ defined in the interval $[0,1)$ can be approximated to be Formula 4, in which C and $\psi(t)$ are Formula 5 and Formula 6 respectively.

$$f(t)\approx\sum_{n=1}^{2k-1}\sum_{m=0}^{M-1}\rho_{nm}\psi_{nm}(t)=C^T\psi(t) \tag{4}$$

$$C=[c_{10},c_{11}\cdots c_{1M-1},c_{20}\cdots c_{2M-1}\cdots c_{2^{k-1}0}\cdots c_{2^{k-1}M-1} \tag{5}$$

$$\psi(t)=[\psi_{10}(t),\psi_{11}(t),...\psi_{1M-1}(t).......\psi_{2^{k-1}M-1}(t) \tag{6}$$

By setting as the activation function of neural network, a Legendre wavelets neural network can be constructed through Formula 5 with a structure as follows. ① Input layer: to input digitalized original signals; ② Preprocessing layer: to divide the digitalized original signals inputted into 2^{k-1} groups, which will enter the corresponding Legendre wavelets basic function to get training; ③ Hidden layer: divided into 2^{k-1} group nodes with each having M Legendre wavelets basic functions to receive signals after preprocessing respectively. The weight for the hidden layer nodes are the proximity of Legendre wavelets coefficients, ④ Output layer: to receive the output of the hidden layer. The output layer is linear nodes which are added to get the result.

4.2 Algorithm Model

In solving the Legendre wavelets, the values of M and k can be increased for better accuracy. The increase of value of k is equivalent to subdivide the interval $[0,1)$ further, while the increase of value of M is equivalent to increase the coefficient of the highest order of the polynomial on the correspondingly subdivided intervals. Considering the actual accuracy requirement and the of the printer and the calculated amount of the model, 3 is given to M and 2 is given to k in the actual solution. According to Formulas 4, 5 and 6, there are six Legendre wavelets basic functions, as is shown in Formula 7. Fig.1 offers its network structure.

$$\begin{aligned}\psi_{10}&=2^{1/2}\\ \psi_{11}&=6^{1/2}(4t-1),\quad 0\le t\prec 1/2\\ \psi_{12}&=10^{1/2}[\frac{3}{2}(4t-1)^2)-\frac{1}{2}]\\ \psi_{20}&=2^{1/2}\\ \psi_{21}&=6^{1/2}(4t-3),\quad 1/2\le t\prec 1\\ \psi_{22}&=10^{1/2}[\frac{3}{2}(4t-3)^2)-\frac{1}{2}]\end{aligned} \tag{7}$$

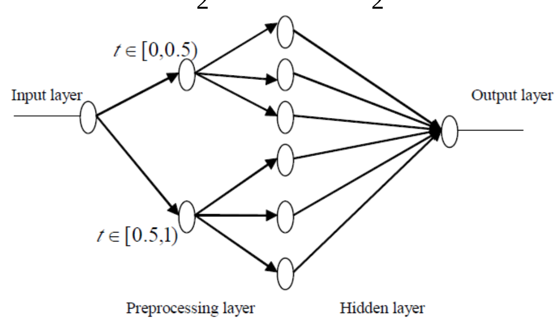

Figure 1: Diagram Of Network Structure

4.3 Algorithm Solution

(1) Network training: In this algorithm, both weight value and threshold value are randomly picked out in the range of -0.5~0.5, with adequate adjustment with regard to the real convergence[9].

(2) Initialization: to initialize the weight coefficient with a small random number.

(3) Circulation: to set an iteration number and load data to undergo network training. The weight coefficient required is acquired once the accuracy of designated logistics enterprise edges is reached.

(4) Keep the value of weight coefficient of Legendre wavelets neural network and conclude the training.

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5. EXPERIMENT CONFORMATION

This paper adopts four Chinese logistics enterprises as the samples for study data which are respectively from annual reports of 2010, official websites of each logistics enterprise and Almanac of China's Finance and Banking of 2010. ①As to the time consuming of the model presented in the paper, table 1 shows the time needed for original BP neural network and improved BP neural network, and the experiment is conducted through PC. PC configurations are as follows: P4 2.5G CPU and 512M memories. The experiment results of the table show that the calculation time of improved BP neural network is 7 second which is practical for engineering use, and the calculation time of the original BP neural network[9] is 245 second that is too long for practical use; ② As to evaluation of four Chinese logistics enterprises can be seen table 1. Limited to paper length, here only demonstrate second-grade indicator material resources and overall evaluation results.

Table.1 Evaluation Results Of Four Logistics Enterprises

	1	2	3	4
Material Resource	0.0001	0.0038	0.0048	0.0081
Human Resource	0.0121	0.0113	0.0089	0.0121
Management Capability	0.0084	0.0000	0.0108	0.0041
Product Capability	0.0001	0.0010	0.0011	0.0041
Regular Customer	0.0022	0.0002	0.0003	0.0007
Social Economic Environment	0.0112	0.0183	0.0133	0.0029
Overall Results	0.6341	0.5642	0.6124	0.5421

6. CONCLUSION AND DISCUSSION

The concept of value network breaks through the scope of original value chain; value network, in a greater range, according to customers' demand, forms a virtual value network constituted by all these cooperative enterprises. Thus, there is a favorable application prospect for the analysis and evaluation of competitiveness of Logistics Enterprises based on the principle of value network. This paper, on the basis of the principle of value network, analyzes and builds evaluation system of competitiveness of logistics enterprises, makes use of BP neural network evaluation method to establish evaluation model of competitiveness of logistics enterprises, also carries out case study taking the data of four Logistics Enterprises as an example, accordingly analyzing the competitive edge of logistics enterprises, meanwhile, the evaluation method built in this paper can be reference for the analysis and evaluation of other multi-factor systems.

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