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Http://www.cscanada.org Http://www.cscanada.net
E-mail: mse@cscanada.org; caooc@hotmail.com

Based on the Efficiency Coefficient-BP Neural Network Study of the Risk of Early Warning

TAO Yong-hong [1]
QI Ai-lin[2]

Abstract: We all expect that we can predict the risk before it appears, the risk of early-warning has become a research hotspot in many fields, so does the economy of risk early-warning. In recent years, using Artificial Neural Network to solve the risk of early warning problem has been developed, but the risk of early warning process often encounters such a problem: The risk assessment has no standard, meanwhile BP Neural Network is a kind of instructors train, and instructors come from the standard. This paper combines Efficacy Coefficient Method and BP Neural Network to achieve the purpose of early warning on the economy problem, it has remedies the limitation of risk of early warning by simply using BP neural network.
Key words: Risk Early Warning; Efficiency Coefficient Method; BP Neural Network

1. INTRODUCTION

In early-warning problem, it often appears that the danger lines are difficulty to define. Although some methods such as Efficacy Coefficient Method can rank the risk, because of the lag of statistical data, ranking risk can not be reaching the purposes of early warning. Only use trained BP neural network can be used to predict and alarm, but because of the network belongs to guide learning, so it needs the data to be trained with a standard measurement, that is the ranking risk. Thus data input can not be achieved the purpose of training the network. The combination of two methods can complement each other, it called EC-BP.

[1]School of Economics and Management, Jiangsu University of Science and Technology, Zhenjiang Jiangsu, 212003,China.
[2] School of Economics and Management, Jiangsu University of Science and Technology, Zhenjiang Jiangsu, 212003,China.
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2. EARLY WARNING PROCESS BASED ON EC-BP

First use Efficacy Coefficient Method to evaluate the historical period risk, given an integrated early warning score, according to the score numerical value and early warning lines of pre-set criteria to determine risk. the calculated results as the expected output of BP network, so as to calculate the error of the expected output and actual output, and thus train the network to be an ideal network model, early warn the next period. The Specific procedure as shown below:

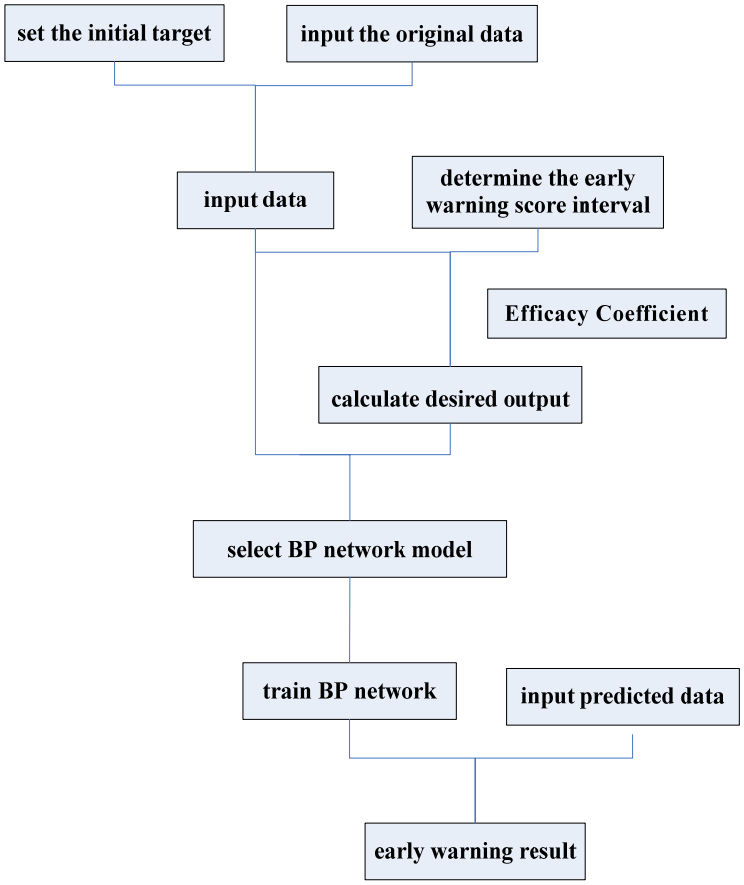

Fig.1.1 map of early warning process based on EC-BP

3. PRINCIPAL COMPONENT ANALYSIS PROCESS

In this paper, it calculates the weights of various indicators by principal component analysis, different from traditional qualitative methods to determine the weight, it can get rid of man-made factors, starting from the data to identify the relationship between the data, so as to determine the weight of each indicator.

Suppose there are n samples taken into consideration, each sample has p observed value, the original matrix X , and then the calculation represented as:

First, standardize the original data. Second, establish correlation coefficient matrix of variables. Third, calculate the characteristic roots $\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p > 0$ and the corresponding unit eigenvectors. Fourth, select m（$m < P$）principal components, making $\alpha = \sum_{i=1}^{m} \lambda_i \Big/ \sum_{i=1}^{p} \lambda_i$（$\alpha \geqslant$ 85%）, select y_1 as the first principal component, y_2 as the second principal component, ... , y_m as the m th principal component. Among them, the first principal component y_1 corresponds to the characteristic root λ_1 , the rest and so on (L.Bobrowski, M.Topczewska, 2008). Fifth, make the explanations to economic phenomena by selected principal component.

Calculate the sum of squares of indicators eigenvector and the weight of indicators, the weight of other indicators and so on.

$$a_k = a_{k1}{}^2 + a_{k2}{}^2 + \cdots + a_{km}{}^2$$

$$w_k = \frac{a_k}{\sum_{k=1}^{n} a_k}$$

Where a_k is the eigenvector of indicator k , k is the number of indicators, m is the number of principal components, w_k is the weight of indicator k .

4. EVALUATION PROCESS OF EFFICACY COEFFICIENT METHOD

Efficacy coefficient method is based on multi-objective decision making theory, it ascertain a satisfactory value and unallowable value of each evaluation indicator to determine the value of each indicators to achieve satisfactory level, calculate the fraction of the indicators through satisfactory value to the ceiling and unallowable value to the lower limit. After educing weighted mean, then the situation of research objective can be evaluated.

$$G_{\min} = \sum_{k=1}^{n} w_k \begin{cases} \frac{x_a - x_u}{x_s - x_u} \times 40 + 60 & (\textit{Actual Value} > \text{Satisfacto ry Value} \\ 100 & (\textit{Actual Value} < \text{Satisfacto ry Value}) \end{cases}$$

$$G_{\max} = \sum_{k=1}^{n} w_k \begin{cases} \frac{x_a - x_u}{x_s - x_u} \times 40 + 60 & (\textit{Actual Value} < \text{Satisfacto ry Value}) \\ 100 & (\textit{Actual Value} > \text{Satisfacto ry Value}) \end{cases}$$

$$G = G_{\min} + G_{\max}$$

Where G is efficacy coefficient of risk factor, $G_{\min}$ is efficacy coefficient of the minimal value, $G_{\max}$ is efficacy coefficient of the maximum value , count $w_k (k = 1, \cdots, n)$ as indicator of

weight, x_a is the actual value, x_u is unallowable value, x_s is satisfactory value.

Idea using Efficacy Coefficient Method to early warning of particular process is as follows:

First, select early warning lines; they are huge, great, moderate, light and no warning respectively.

Second, use hierarchical analysis or principal component analysis method to determine the weight of each early-warning indicator.

Third, set a single area of early warning indicators, and come with the weight of each early-warning indicator to determine the integrated early warning score interval.

Fourth, calculate the efficacy coefficient.

Fifth, determine the early-warning lines basis on the efficacy coefficient and integrated early warning score interval.

5. EARLY WARNING BASIC ON NEURAL NETWORK

5.1 Algorithm for the Calculation

STEP1: Initialize network, set the initial parameters of the network.

STEP2: Input learning algorithm.

STEP3: Calculate the middle layer unit output.

STEP4: Calculate the output layer unit output.

STEP5: Calculate the error between the output layer unit and the desired output.

STEP6: Adjust the connection weights from middle layer to output layer and the off-set of output layer units[2].

STEP7: Adjust the connection weights from input layer to the middle layer and the off-set of the middle layer units.

STEP8: Update learning algorithm, if the learning algorithm is over, get to the next step, otherwise return to STEP2;

STEP9: Update learning number, if get to the maximum number of learning, then end, otherwise return to STEP2.

5.2 Error function

Suppose there are p samples or p periods of data, the network output m units, due to the risk of early-warning has a time-related features, we must measure the value of next period to give an indicator of early warning. For the risk prediction is a time-related function, it needs to reflect the characteristic in the BP neural network. Therefore, the efficacy coefficient of the next period will be regarded as the current period desired output in this article, which the error formula during the third layer of the network is:

$$e_p = D^{p+1} - y^p$$

Where D^{p+1} is efficacy coefficient of the risk factors of the ($p+1$)th period, y_p is f the actual

output value of samples p .

Error of sample p is represented as:

$$E_p = \frac{1}{2}\sum_{i=1}^{m} e_{pi}^{\ 2}$$

Where m is the dimension of output, namely, the output quantity.

By the formula flowered the BP network error formula is represented as[3]:

$$E_{总} = \frac{1}{2}\sum_{p=1}^{p-1}\sum_{i=1}^{m}(D_i^{p+1} - y_i^p)^2$$

The use of neural network design model, need to select the appropriate parameters to get fast convergence and accurate results to the desired effect.

6. CONCLUSIONS

There are many methods for the economic early warning, such as: Autoregressive Moving Average Model, Vector Autoregressive System, Auto Regressive Conditional Heteroscedasticity Model, KLR and so on [4],[5],[6]. Neural network is a widely used method. It can effectively solve most of the economic early warning. This paper combines Artificial Neural Network and Efficacy Coefficient in practice, to make it more practical significance. However, the features which include convergence speed, network performance of BP Neural Network can be improved, which is the future researchers should pay attention to.

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