Risk Early-Warning Model of High-Tech Entrepreneurial Enterprise Based on BP Neural Network

Xiaofeng Li[1], Wang Tian[1] and Ke Wu[2]
[1] Department of *Management science, School of Business, Sichuan University, Chengdu 610064, P.R. China*
[2]*Department of enterprise management,* School of Business, Sichuan University, Chengdu 610064, P.R. China
{*f*_author, *t*_author}lixiaofeng@scu.edu.cn

Keywords: High-tech, Entrepreneurial enterprise, BP Neural network, Risk early warning.

Abstract: Entrepreneurship is a high-risk activity. In the entrepreneurial process, it may cause a significant loss or even bankruptcy for entrepreneurial enterprise if entrepreneurial enterprise cannot prevent and control risk effectively. Therefore, it is very necessary to use scientific and effective methods to estimate and control the early risk of entrepreneurial enterprise. In this paper, the index system of the risk early warning of high-tech entrepreneurial enterprise was built. Then based on artificial neural network theory, the BP neural network model of high-tech entrepreneurial enterprise's risk early warning was established, and the relevant algorithm was proposed too. With good ability of fault-tolerance and adaptability, this model avoids the subjectivity of the man-made interference in the course of risk early warning, which provides a new approach for the risk early warning of high-tech entrepreneurial enterprise. The result of empirical research indicates that the risk early warning model of high-tech entrepreneurial enterprise based on BP neural network is strongly scientific, practical and effective, thus it is worthy being popularized and applied.

1 INTRODUCTION

With the development of society and technology, people are paying more attention to the technology content of the products, and more and more scientists and technicians start their businesses on high-tech projects. However, high-tech entrepreneurship is an activity of high risk for the entrepreneurs. The uncertainty of external environment, the difficulty and complexity of the project and the limitation of the entrepreneurs' ability could possibly lead to a delay, a halt or a failure. According to some references in the United States, entrepreneurial success rate is less than 25%, while high-tech entrepreneurial success rate is less than 10% (Motiar Rahman, Kumaraswamy, 2003). So, it is very necessary to build an efficient risk early warning system of high-tech entrepreneurial enterprise for the management of entrepreneurial risk.

At present, entrepreneurship risk management has attracted more and more scholars' attention. Consequently, some achievements have been obtained (Zhongrui Wang, Shaojun Ma, Yitian Xu, 2003; Yuhua Li, Hongwen Lang, 2004; Pena I, 2002; Shimizu, Katsuhiko, 2012). In those papers, the risk early warning model of entrepreneurial enterprise is built mainly by Fuzzy Evaluation Method, ANN(Artificial Neural Network), Multivariate Statistical Analysis and Zeta Model. These methods need to rely on historical samples and expert experience, the learning of early warning knowledge is indirect and inefficient. Besides, dynamic early warning capability is Inadequate. As a result, the predictions are not perfect enough. So, it is necessary to apply other technologies and analysis methods to research the risk early warning of entrepreneurial enterprise. Using the method of ANN (Artificial Neural Network), this paper establishes the BP neural network model of high-tech entrepreneurial enterprise's risk early warning. The empirical research indicates that this model has adaptive ability, learning ability and capability of dealing with non-linear problems, which provides a new approach for the risk early warning of entrepreneurship.

The paper is organized as follows. In section 2, the index system of the risk early warning of high-tech entrepreneurial enterprise is built. In section 3, the traditional BP artificial neural network is introduced. In section 4, based on artificial neural network theory, the BP neural network model of

Wu K., Tian W. and Li X.
Risk Early-Warning Model of High-Tech Entrepreneurial Enterprise based on BP Neural Network.
DOI: 10.5220/0006442900130018
In *ISME 2016 - Information Science and Management Engineering IV (ISME 2016)*, pages 13-18
ISBN: 978-989-758-208-0

13

high-tech entrepreneurial enterprise's risk early warning is established. As an application of model, we discuss a consumption level forecast problem in section 5. Some concluding remarks are finally given in section 6.

2 THE RISK EARLY WARNING INDEX SYSTEM

High-tech entrepreneurial enterprise refers to new-born enterprises engaged in the research and development of the advanced technologies, producing high-tech products and representing the direction of future industrial development. High-tech entrepreneurial enterprise is characterized by high investment, high risk and high yields (Zhi Zhuo, 2006). Risk early warning of high-tech entrepreneurial enterprise is to research on the important indexes that reflect the operations of the entrepreneurial enterprise by applying certain methods and obtain the actual risk profile. To achieve this, a risk early warning index system of entrepreneurial enterprise is required in the first place. There are many factors that influence normal operation of the high-tech entrepreneurial enterprise and the relations among the factors are complex. So, the following principles should be followed:

(1) Comprehensive principle. The index system should have a wide coverage and be able to completely reflect the practical results and existing problems of the risk early warning management.

(2) Sensitive principle. The index system is required to reflect the risk precisely and sensitively and embody the true state of the enterprise's operation in time.

(3) General principle. High-tech entrepreneurial enterprise has different types of risk in different growth periods, so the index system must have high ability of generalization and be able to reflect the most essential features.

(4) Measurable Principle. The index system is required to be represented by precise and quantitative numerical values which derive not only from empirical research but also from expert evaluation.

(5) Irrelevant principle. Cut down the relevant relations and overlapping area between the indexes as far as possible and reduce the correlation to a minimum.

According to the principles above, the factors that influence the normal operation of the enterprise are classified into several parts that form the frame of the index system. By sending questionnaires, interviewing experts and referring to some literature at home and abroad (Yanping Yang, 2005; Qun Xie, Xiaozhe Yuan, 2006; Rennan. M, Schwartz .E, 2006; Fengchao Liu, Yuandi Wang, 2004), the frame is subdivided, supplemented and deleted in detail. Finally, the index system is built, as is shown in table 1.

Table 1: The risk early-warning index system of High-Tech entrepreneurial enterprise.

First-class index	Second-class index
environmental risk	industrial policy
	legal environment
	industrial status
technical risk	technical advancement
	technical reliability
	technical substitutability
	ability of research and development
market risk	market demand
	market share
	sales growth
	competitor capability
	barriers to entry
financial risk	fund-raising ability
	sales profit rate
	internal rate of return
	financial management capacity
human resources risk	employee overall quality
	employee turnover rate
	core Taff Turnover possibility
management risk	management capability of entrepreneurial team
	stability of entrepreneurial team
	social resources of entrepreneurial team

Risk Early-Warning Model of High-Tech Entrepreneurial Enterprise based on BP Neural Network

3 BP NEURAL NETWORK ARCHITECTURE AND ALGORITHM

A standard back propagation neural network is shown in Figure 1. The first layer consists of n input nodes. Each of the n input nodes is connect to each of the r nodes in the hidden layer. The r output nodes of the hidden layer are all connected to each of the m node in the output layer.

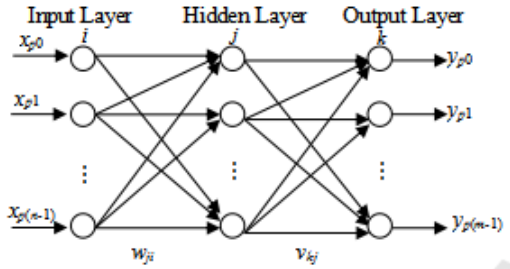

Figure 1: A standard BP artificial neural network.

BP is a supervised learning algorithm for multilayer networks (Naiyao Zhang, Pingfan Yan, 1998). The algorithm aims at minimizing the MSE between the actual output of the network and the desired output. Gradient descent search is user in BP. In BP learning, a set of patterns of the form $<x_1,\ldots,x_n, y_1,\ldots, y_m>$, where $x_1,\ldots, x_n$ are the components of the input vector and $y_1,\ldots, y_m$ are the components of the desired output vector, is repeatedly given to the network until the learning of weights converges (Liming Zhang, 1993).

If the BP neural network has N nodes in each layer, The transfer function is the sigmoid function, , the training samples involve M different patterns (Xp, Yp), P=1,2,…M. Corresponding the Input sample P, let netpj represent the input total of node j, let O_{pj} represent the output value, that is

$$net_{pj} = \sum_{j=0}^{N} W_{ji} O_{pj} \qquad O_{pj} = f(net_{pj})$$

The error between input values and output values is as following:

$$E = \sum E_p = (\sum (d_{pj} - O_{pj})^2)/2$$

The revise connection weights of BP neural network are as following:

$$W_{ji} = W_{ji}(t) + \eta \delta_{pj} O_{pj} + \alpha (W_{ji}(t) - W_{ji}(t-1))$$

$$\delta = \begin{cases} f(net_{pj})(d_{pj} - O_{pj}) & \text{corresponding the output nodes;} \\ f(net_{pj}) \sum \delta_{pk} W_{kj} & \text{corresponding the input nodes.} \end{cases}$$

Where η represents the learning rate, it can increase convergence in speed, α represents the momentum coefficient. The value of a is a constant, it affects the connection weights of next step. Details of the traditional BP artificial neural network algorithm can be found in the original paper by Jingwen Tian and Meiquan Gao (Naiyao Zhang, Pingfan Yan, 1998).

The input/output problem of one set of samples is changed by the traditional BP network model into a nonlinear optimization problem with a very common algorithm---Gradient Descent. This traditional model has strong ability of problem identification and can reduce the errors to a minimum theoretically for the simulation of complex and nonlinear models. However, this traditional model still has some drawbacks (Liqun Han, 2002), so we improve it and put forward the BP neural network of self-adjusted all parameters learning algorithm (Xiaofeng Li, 2003). The new algorithm can not only accelerate the convergence speed of the network but also optimize the network topology and enhance the adaptability of the BP neural network.

4 THE MODEL ARCHITECTURE OF EARLY RISK WARNING

4.1 The Risk Early Warning Index Assignment Method

In section 2, the risk early warning index system of high-tech entrepreneurial enterprise is built, but most second-class indexes are hard to be represented directly by numbers. We can adopt the fuzzy statistical method to find out the functions and get the valuations of these second-class indexes. Comment set consisting of evaluation levels in descending order is V= {excellent, fine, ordinary, bad} = $\{A_1, A_2, A_3, A_4\}$ = {1, 2, 3, 4}.

According to fuzzy statistics, the experts involved in the evaluation are required to grade the indexes. Next, we count the frequency m_{it} of each index u_i belonging to grade A_t.

Let us denote

$$\mu_i^{(t)} = \frac{m_{it}}{n}$$

$\mu_i^{(t)}$ represents the degree of index u_i belonging to grade A_t.

Let us denote

$$R_i = \mu_i^{(1)} / A_1 + \cdots + \mu_i^{(4)} / A_4$$

R_i represents the value of index u_i.

15

4.2 BP Neural Network Model Architecture

Based on the traditional ANN (Artificial Neural Network), the BP network model architecture of early risk warning of high-tech entrepreneurial enterprise is divided into three layers:

(1)Input layer: The input variables are the second-class indexes of the index system (shown in table 1), so there are 22 input layer nodes. Then, the indexes are given values using the evaluation method illustrated in section 4.1. These values would be learning samples of the BP network.

(2)Hidden layer: When it comes to the selection of the number of hidden layer nodes, referring to the BP neural network of self-adjusted all parameters learning algorithm that is mentioned in paper [15], we set the number of nodes large enough at the beginning. Then, the network will learn by itself until we get the appropriate number of nodes.

(3)Output layer: The early risk warning of high-tech entrepreneurial enterprise is a process from qualitative analysis to quantitative analysis and back to qualitative analysis. This model converts the qualitative to quantitative output. Then, we warn the risks according to the comment set and output. The risks are classified into four levels: safe, light, serious, and dangerous. These levels can be represented by the output vectors (1,0,0,0), (0,1,0,0), (0,0,1,0), (0,0,0,1). So, the number of output layer nodes is four.

4.3 BP Neural Network Model Algorithm

The BP neural network model algorithm is as follows:

Step 1: Give values to the indexes and input them as variables to the neural network.

Step 2: Set the number of input nodes and initialize the parameters (including the learning accuracy ε, the prescribed number of iterative steps M, the upper limit of hidden layer nodes, learning parameter b, momentum coefficient *a*, the number of initial hidden layer nodes a should be large.)

Step 3: Input the learning samples and make the values of sample parameters [0, 1].

Step 4: Give random numbers between -1 and 1 to the initial weighting matrix.

Step 5: Train the network with the modified BP method.

Step 6: Judge whether or not the number of iterative steps is exceeding the prescribed. If yes, end; If no, go back to step 5 and continue learning.

Step 7: Collect the values of the indexes and process these data to make them [0, 1].

Step 8: Input the processed data to the trained BP neural network and get the output.

Step 9: Warn the risk early of the entrepreneurial enterprise according to the output and the risk level comment set.

5 EMPIRICAL RESEARCH

We select 17 high-tech entrepreneurial enterprises in SiChuan high-tech industrial zone; Chi Tong Digital LLC(Q1); DI Zhong Digital LLC (Q2); Guang Hua Science and Technology LLC(Q3); Chen Jing Electronics(Q4); Hui Jin Science and Technology LLC(Q5); Gao De Software(Q6); Tian Sheng Science and Technology LLC(Q7); Data System LLC(Q8); Network Educational Technology(Q9); Communication Technology Company(Q10); Kai Yuan Information LLC (Q11); Hua Run Science and Technology LLC(Q12); Bo Yu Tong Da LLC (Q13); Global Technology (Q14);Traffic Engineering Company(Q15); Internet of Energy Company (Q16); Xing Ge Science and Technology LLC(Q17); The experts are invited to evaluate the operation risks of these entrepreneurial enterprises by using Delphi method and AHP method. We come to a conclusion: the risk level of Q1、Q2、Q7、Q13 is ‘safe’; the risk level of Q3、Q4、Q8、Q9、Q14 is ‘light’; the risk level of Q5、Q10、Q11、Q15 is ‘serious’; the risk level of Q6、Q12、Q16、Q17 is ‘dangerous’. We take 12 enterprises at the top of the list as the training samples of BP network model and the last 5 enterprises as the prediction samples.

5.1 BP Neural Network Training

The BP neural network architecture is built by 22-30-4 (The number of input layer nodes is 22, the number of hidden layer nodes is 30, the number of output layer nodes is 4). We initialize the network (the upper limit ε=0.0002, learning rate, η=0.5, Inertia Parameter *a*=0.1), give values to the indexes of risk early warning of the 12 high-tech entrepreneurial enterprises (Q_1-Q_{12}) and input the processed data to the BP network model. Then the network is trained by the modified BP learning algorithm and the network architecture becomes 22-15-14. At the same time, we get the optimized network weight matrix.

Risk Early-Warning Model of High-Tech Entrepreneurial Enterprise based on BP Neural Network

5.2 Risk Early Warning

Now, it is time to early warn the risk of the enterprises Q_{13}、Q_{14}、Q_{15}、Q_{16}、Q_{17} utilizing the trained neural network. Give values to the risk early warning indexes of the 5 high-tech entrepreneurial enterprises, input the processed data to the trained BP neural network and get the output of risk early warning. As is shown in table 2 and table 3, the predictions of BP neural network accord with the practical ones completely, which indicates that this risk early warning model feasible and effective.

Table 2: BP neural network output.

High-tech Entrepreneurial Enterprise	Network Reasoning Output
Q_{13}	（**0.9985** 0.0023 0.0362 0.0078）
Q_{14}	（-0.0059 **0.9911** 0.0038 0.0011）
Q_{15}	（0.0131 –0.0016 **1.0005** 0.0077）
Q_{16}	（0.2201 0.0415 –0.0562 **0.9991**）
Q_{17}	（-0.0072 0.0035 0.0009 **0.9589**）

Table 3: BP neural network reasoning.

High-tech Entrepreneurial Enterprise	Network Predictions	Practical Risk Level
Q_{13}	Safe	Safe
Q_{14}	light	light
Q_{15}	Serious	Serious
Q_{16}	Dangerous	Dangerous
Q_{17}	Dangerous	Dangerous

6 CONCLUSIONS

From the analysis above, we come to the following conclusions.

(1)This paper builds a risk early warning model of high-tech entrepreneurial enterprise by taking advantage of the self-organization ability, self-adjustment ability and self-learning ability of BP neural network. This model has a good effect on the risk early warning of these enterprises. The influence of human factors and fuzzy randomness brought by human evaluation can be eliminated, which makes the evaluations more objective and accurate.

(2)This paper takes the values of the risk early warning indexes as the learning samples of the model. These samples will dynamically learn evaluating and reasoning by themselves. With time passing and samples increasing, further study and dynamic tracking will be carried out.

(3)Nonlinear functions that applies to the complex, nonlinear and dynamic economy system are used in BP neural network, which gets rid of the linear analysis tools in classical economics and provides more accurate information. So, this method has great advantage over the traditional ones and provides an effective path for risk early warning of entrepreneurial enterprises.

ACKNOWLEDGEMENTS

This research was supported by the national social science foundation of China, No.16BGL024.

REFERENCES

Fengchao Liu, Yuandi Wang, 2004. Evaluation Mode of Risk Investment Based on Principal Component Analysis. *Science & Technology Progress and Policy*, (3): 65-67.

Liming Zhang, 1993. *Artificial neural network model and its application*, Fudan University Press. Shanghai, 1st edition.

Liqun Han, 2002. *Artificial neural network theory, designing and application*. Chemical Industry Press. Beijing, 2nd edition.

Martin T. Hagan, Howard B. Demuth, Mark Beale, 1996. *Neural Network Design*, PWS Publishing Company, Thomson Learning.

Motiar Rahman, M., Kumaraswamy, M., 2003. Risk management trends in the construction industry: moving towards joint risk management. *Engineering Construction and Architectural Management*, 9(2): 131-151.

Naiyao Zhang, Pingfan Yan, 1998. *Neural Networks and Fuzzy Control*, Tsinghua University Press. Beijing, 1nd edition.

Pena I, 2002. Intellectual Captital and Business Venture Success. *Journal of Intellectual capital*, (3): 180-198.

Qun Xie, Xiaozhe Yuan, 2006. A review of the evaluation system of venture investment projects. *Science and Technology Management Research*, (8): 182-187.

Rennan. M, Schwartz. E, 2006. Evaluating National Resource Investments. *Journal of Business*, 58(1): 135-157.

Shimizu, Katsuhiko, 2012. Risks of Corporate Entrepreneurship: Autonomy and Agency Issues. *Organization Science*, 23(1): 194-206.

Xiaofeng Li, 2003. The establishment of forecasting model based on BP neural network of self-adjusted all parameters. *Forecasting*, 20(3): 69-71.

17

Yanping Yang, 2005. Risk law of high-technology venture investment. *Science and Management of S.& T.*, (03): 78-82.

Yuhua Li, HongWen Lang, 2004. Research on fuzzy overall evaluation model for investment risks in high-tech projects. *Journal Harbin Univ .Sci.& Tech,* 9(1): 72-75.

Zhi Zhuo, 2006. *Research on risk management theory*, China Financial Press. Beijing, 1st edition.

Zhongrui Wang, Shaojun, Yitian Xu, 2003. On the method of fuzzy and synthetic judgment to judge the risk of high-tech projects. *Journal of Shihezi University (Philosophy and Social Science)*, 3(3): 59-62.

APPENDIX

Xiaofeng Li (1972-), male, post doctoral, research interests include entrepreneurial management, project management, etc.
[E-Mail:] Lixiaofeng@scu.edu.cn