1. Preface

Starting from Jan. 01, 2002, Taiwan had become a formal member of World Trade Organization (WTO). After joining WTO, the benefits that Taiwan can acquire include the participation of the preparation of international economic and trading standards, the solving of economic and trading dispute through dispute solving mechanism, the promotion of industry upgrading and the improvement of enterprise ’s competitiveness, the enhancement of consumer ’s welfare and the enhancement of living quality, etc. However, if there is an advantage, there must be an accompanied disadvantage; facing with the pressure to open the market, many industries in Taiwan thus have to face the competition, and the market becomes more difficult to manage, some less competitive enterprises usually have to face with bad business operation or financial difficulty issues; once financial difficulty occurs in an enterprise, not only the living of employees of the enterprise will be affected, but also the interest of the investors will be affected. However, the causes for financial difficulty in an enterprise, in addition to the external macroeconomic environment and industry characteristic factor, may also include the problem of enterprise itself, for example, bad management in the enterprise, bad business strategy and high financial leverage, etc.; all these factors and the results will be reflected in the financial statement. Therefore, before investors or researchers are making investment strategy decision, they must collect the financial report and related data of the target enterprise so as to understand in depth the business operation status and future vision of the target enterprise.

However, in the past when researchers constructed forecast model so as to evaluate enterprise ’s operation performance, most of the ways they take are financial warning (Beaver, 1996; Altman, 1968) or credit scoring (Ta-Cheng Chang, 2003; Chi-Hua Yen and Meng-Tse Tsai, 2006), etc. In this article, another way for predicting enterprise ’s operation performance is proposed, that is, the operation capability of an enterprise is analyzed through the financial statement of the enterprise as audited, signed and announced by an accountant. In this article, the financial report data of the enterprise is used to perform Data Envelopment Analysis (DEA) as used by Coelli, et al.(1998). The obtained technical efficiency value is then dichotomized into good business operation enterprise and bad business operation enterprise; then the financial ratio data of the enterprise is used to perform Principal Component Analysis, to select classification model and input the variables, and finally, the construction of the business operation performance forecast model is performed. In the model construction aspect, this article uses sample data to construct Probabilistic Neural Network (PNN) forecast model, then classification capability comparison an d test is done with general Back-Propagation Networks (BP), Decision Tree (DT) and Logistic Regression (LR) model, and finally, a conclusion is made.

The main structure of this article is: In the first section, brief introduction of the research motivation, objective and flow of this article will be done; in the second section, related

literature review of Probabilistic neural network will be done; in the third section, the research methods adopted in this article will be introduced; in fourth section, experimental result analysis and inspection will be done; finally, research conclusions and suggestions will be made.

2. Probabilistic neural network

Probabilistic neural network is a three layers Feed-forward Neural Network (as in figure 1). The first layer is input layer with the neural unit number as the independent variable number and it can receive input data; the medium second layer hidden layer is pattern layer, which is used to store each training data, and the output data of pattern layer will pass through the neural unit of the third layer summarization layer and get corresponded to each possible category; this layer will perform the calculation of equation (3). The fourth layer is competition layer and the competition transfer function of this layer will select the maximum value of these probabilities from the previous layer output and generate the output value. When the output value is 1, it is the category wanted; but when the output value is 0, it is the category not wanted.

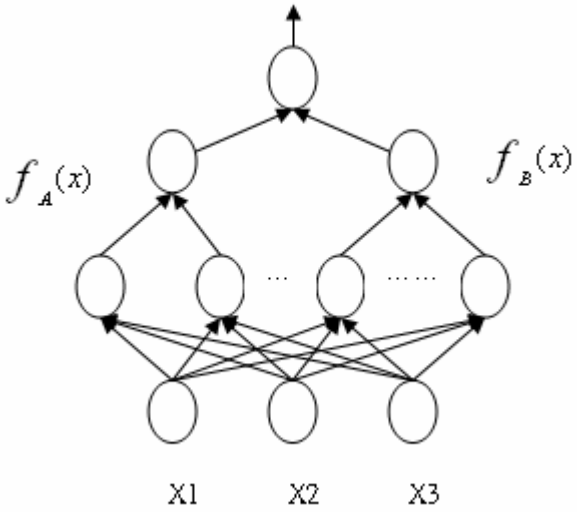

Figure 1 The structural diagram of Probabilistic neural network

This network is a monitoring type network structure with its theory built on Bayes Decision and non-parametric technique to estimate probability density function (PDF); tge probability density function is of Gaussian distribution. Specht (1990) had proposed such function:

$$f_k(X) = \left(\frac{1}{N_k}\right)\left(\frac{1}{(2\pi)^{m/2}}\right)\left(\frac{1}{\sigma^m}\right)\sum_{j=1}^{N_k}\exp\left(-\frac{\|X - X_{kj}\|}{2\sigma^2}\right) \quad (1)$$

Since Probabilistic neural network is applicable to general classification problem, assume the eigenvector to be classified must belong to the one of the known classifications, then the

absolute probability value of each classification is not important, only the relative value needs to be considered, hence in equation (1)(Yi-Cheng Yeh, 1998)

$$\left(\frac{1}{(2\pi)^{m/2}}\right)\left(\frac{1}{\sigma^{m}}\right)$$

can be neglected and equation (1) can be simplified as

$$f_k(X) = \left(\frac{1}{N_k}\right)\sum_{j=1}^{N_k} \exp\left(-\frac{\|X - X_{kj}\|}{2\sigma^2}\right) \quad (2)$$

In equation (2), σ is the smoothing parameter of Probabilistic neural network; after the completion of network training, the forecast accuracy can be enhanced through the adjustment of smoothing parameter σ, that is, the higher the value, the smoother the approaching function. If smoothing parameter σ is not appropriately selected, it will lead to too much or too few in the neural unit number of the network design; hence, during function approaching, it will lead to over fitness and inappropriate fitness, and the forecast capability will be reduced.

Let $d_{kj}^2 = \|X - X_{kj}\|$

be the square of Euclid distance of two points of X and X_{kj} in the sample space, then equation (2) can be re-written to

$$f_k(X) = \left(\frac{1}{N_k}\right)\sum_{j=1}^{N_k} \exp\left(-\frac{1}{2}\left(\frac{d_{kj}}{\sigma}\right)^2\right) \quad (3)$$

In equation (3), when smoothing parameter σ approaches zero

$$f_k(X) = \frac{1}{N_k}$$

If $X=X_{kj,}$, otherwise

$$f_k(X) = 0$$

At this moment, the classification of Probabilistic neural network will be fully dependent on the closest classified sample of the un-classified sample. When smoothing parameter σ approaches infinity

$$f_k(X) = 1$$

At this moment, Probabilistic neural network approaches blind classification. Usually, the researchers need to try different σ in certain range so as to achieve optimal accuracy. Specht (1992) had proposed a method for adjusting smoothing parameter σ, that is, each input neural unit is given a single σ, during the test stage and through micro adjustment of each σ, σ of the best classification result is obtained.

On the classification problem, Probabilistic neural network has been widely used in all kinds of fields. In the medical science aspect, Gorunescu (2005) has applied Probabilistic neural network in the diagnosis of cancer; in civil engineering, Ni(2000) has applied Probabilistic neural network in bridge damage identification; in education field, Fletcher(1998) had used Probabilistic neural network in constructing network platform system to improve

teaching result and evaluation; in image recognition aspect, Wang(1998) had used Probabilistic neural network in Magnetic Resonance Imaging to perform brain tissue image splitting.

3. TTTTTTTTSample data and variable

This article collects financial ratio data as dependent variable on April 2003, April 2004 and April 2005from 287 private enterprises of traditional industries that have their stocks listed in regular stock market or OTC (over-the-counter) in Taiwan as posted in Information Winner Database, Taiwan＇s Economic News Database, Taiwan＇s Open Information Observatory Station; and the DEA data generated by financial statement respectively on Feb. 2004, Feb. 2005 and Feb. 2006 are predicted. Moreover, the sample data can be divided into training data and test data; the test data can be divided into 20% and 30% according to the ratio, it is used to verify the performance of the classification forecast model of the business operation performance of companies with stocks listed in the regular stock market or over-the-counter stock market. However, the financial ratio is selected from five forces analysis of the financial perspective; the financial ratio variable as adopted in this article is as shown in table 1:

Table 1 Financial ratio variable of five forces analysis

Five forces	Variables	Financial ratio name
Activity	X1	Turnover rate of payment receivable
	X2	Turnover rate of inventory
	X3	Turnover rate of asset
Growth	X4	Revenue growth rate
	X5	Fixed asset growth rate
	X6	Total asset growth rate
Stability	X7	Flow ratio
	X8	Self-owned capital ratio
	X9	Fixed ratio
	X10	Quick ratio
Productivity	X11	Return of equity
	X12	Return on tangible asset
Profitability	X13	Business profitability
	X14	Net profit before tax
	X15	Net profit

The dependent variable (Y) used in this article follows production function Y=F(K,L) and refers to Hui-Ying Chen (2000); that is, the total capital value (K) and number of employees (L) from the financial statement of companies with stocks listed in the regular and over-the-counter stock market are used as input items, and the output item is the sale per share ratio of the financial ratio variable; then Data Envelopment Analysis is performed to get technical efficiency value; if the technical efficiency value ≥ 0.5, it is then classified as company of good business operation performance (which is represented by 0). On the contrary, if the technical efficiency value is smaller than 0.5, then it is classified as company of bad business operation performance (which is represented by 1). Then this value is combined with independent variable to form training data and test data for model construction, and then the constructions of all kinds of classification forecast models are performed.

Since the number of independent variable will affect the complexity of neural network, hence, over-fitting issue should be considered, and the correlation among variables should be reduced. Therefore, this article has referred to the method of Bodt et al (2000) to perform Principal Component Analysis (PCA) so as to reduce the number of independent variable, and the details are as in figure 2. The selected number of variable is based on the basic rule of contribution larger than 85%, In the analysis results of sample data of three years, 10 principal components are extracted, with accumulated contributions of respectively 90.595, 85.338 and 85.906.

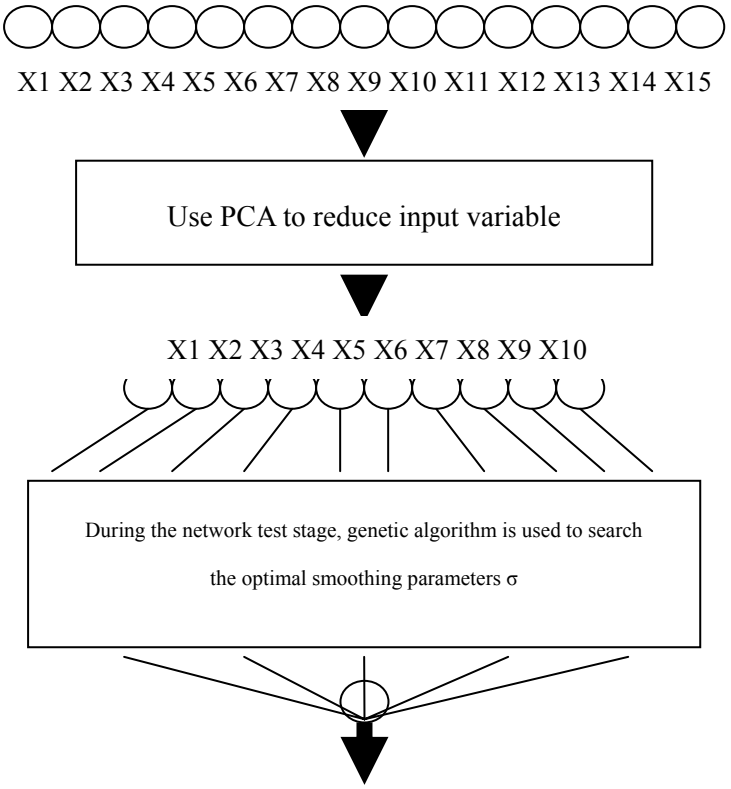

Figure 2 Illustration of data pre-treatment and the steps of selection of network smoothing parameter

Among them, the principal component descriptive and statistical result in 2005 is as shown in table 2:

Table 2 The descriptive statistic of principal component in 2005

Components	N	Maximum	Minimum	Mean	Std
1	287	359.92	-167.17	34.12	43.41
2	287	87.65	-97.11	12.11	26.70
3	287	176.32	-91.34	7.90	44.13
4	287	462.85	-345.06	76.69	47.88
5	287	419.54	-229.88	51.23	39.11
6	287	86.57	-351.91	-11.10	53.97
7	287	227.84	-437.74	-34.47	66.65
8	287	391.45	-156.88	35.87	89.12
9	287	168.89	-238.01	-67.05	43.06
10	287	537.61	-89.19	44.23	67.90