International Journal of u-and e-Service, Science and Technology
Vol.7, No.4 (2014), pp.147-158
http://dx.doi.org/10.14257/ijunnesst.2014.7.4.15

Valuating Goodwill of Cultural Enterprises Using Wavelet Neural Network

Han Dong Ping[1] and Bao Di[2]

[1]School of management, Harbin Institute of Technology, Harbin, Heilongjiang, China

[2]School of management, Harbin Institute of Technology, Wei Hai, Shandong, China

handongping@hit.edu.cn, baodi0824@163.com

Abstract

Goodwill is one of the most valuable intangible assets of companies. Typically, only when some financial behaviors occur, for example, the proper rights of assets to be transferred or invested as shares, it is time to evaluate the value of goodwill. However, we assume that it is necessary to periodically evaluate the goodwill during the normal business period for the sake of maintaining and improving the commercial goodwill of enterprises. To this end, we focus on the problem of valuating the goodwill. Typically, the process of evaluating the goodwill involves two steps. First, a set of factors associated with the goodwill valuation should be abstracted. Second, above factors should be integrated with a proper method. To more precisely value the goodwill, in this paper we propose to employ a Wavelet Neural Network (WNN) based method to train a model based on a series of indicators. Our experiments prove the feasibility and efficiency of our method.

Keywords: *Goodwill, Wavelet Neural Network*

1. Introduction

Goodwill [1] has been one of the most valuable intangible assets of companies. As defined in Accounting Principles Board (APB) Opinion No. 16, goodwill is "the excess of the cost of the acquired company over the sum of the amounts assigned to identifiable assets acquired less liabilities assumed" [2].

After hundreds of years of efforts on goodwill, researchers from both industry and academia have reached to the following agreements. (1) Goodwill can be created by enterprises or persons. Enterprise goodwill or business goodwill comes from the characteristics with regards to business activities, no matter who is the operator [3]; while personal goodwill or professional goodwill is more concerned with specific individual who is responsible for the business [4]. Both categories of goodwill can produce benefits for companies with various factors, such as geographical advantage, trade celebrity, exquisite workmanship and good reputation, etc. (2) Goodwill is always related to some specific subject and cannot be standalone. For example, goodwill is always attached to particular enterprise or owner. (3) Goodwill is transferable [5]. Initially, goodwill draws attentions when the transfer of the business takes place between two parties. (4) Goodwill can be measured by currency [6]. While it is transferable, it must be able to be evaluated with currency. Therefore, how to quantitatively evaluate the value of goodwill is a big challenge.

Typically, only when some financial behaviors occur, for example, the proper rights of assets to be transferred or invested as shares, it is time to evaluate the value of goodwill. However, we assume that it is necessary to periodically evaluate the goodwill during the normal business period for the sake of maintaining and improving the commercial

ISSN: 2005-4246 IJUNNEST

goodwill of enterprises. To this end, in this paper, we focus on the problem of valuating the goodwill.

Typically, the goodwill valuation includes the following steps. First, we need to construct an indicator system with a set of indicators associated with the goodwill valuation. Second, a proper model is employed to combine those indicators in order to evaluate the goodwill value. However, a big challenge is how to learn the model to ensure both the efficiency and accuracy.

Wavelet Neural Network (WNN) [7] is a neural network based on wavelet analysis. It's a new layered multiresolution artificial neural network which is based on nonlinear wavelet to replace traditional sigmoid function, and its signal is presented by linearly aggregating a set of wavelet basis. WNN has the following advantages. First, through scale expansion and translation on signals, wavelet analysis can efficiently extract local information from signals. Second, neural networks are self-learning, adaptive and fault tolerant, and also an approximation of some universal functions. Third, based on the wavelet analysis theories, WNN can avoid the blindness when designing the structures of Back Propagation (BP) neural network [8]. Fourth, WNN has more powerful learning skills and are more precise. Last, the structure of WNN is simpler, and the convergence is faster. Given that WNN is powerful in learning models with high accuracy, in this paper, we propose to utilize WNN for learning to evaluate the goodwill value.

The remains of this paper are organized as follows. Section 2 provides preliminaries, and Section 3 describes some related work. In Section 4, we present our multi-layer indicator system for evaluating goodwill of companies, and a learning process using WNN model is introduced in Section 5. Empirical experiments are conducted in Section 6. Finally, the paper is concluded in Section 7.

2. Preliminaries

In this section, we will briefly introduce some preliminaries about Wavelet Neural Network (WNN).

Choose a mother wavelet function (or basic wavelet function) $\psi(x)$ in a function space $L^2(R)$, which satisfies:

$$C_\psi = \int_R \frac{|\hat{\psi}(w)|^2}{|w|} dw < \infty , \tag{1}$$

where $\hat{\psi}(w)$ is the Fourier transformation of $\psi(x)$. After scaling and translation on $\psi(x)$, we get a wavelet basis function $\{\psi_{a,b}(x)\}$:

$$\psi_{a,b}(x) = \frac{1}{\sqrt{a}} \psi\left(\frac{x-b}{a}\right) \quad (a, b \in R^2) , \tag{2}$$

where a is the scaling coefficient, and b is the translation coefficient.

For any $f(x) \in L^2(R)$, the consistent wavelet transformation is defined as:

$$W_f(a,b) = \frac{1}{\sqrt{C_\psi}} \int_R f(x) \psi_{a,b} dx . \tag{3}$$

And the inversion formula is:

$$f(x) = \frac{1}{C_\psi} \int_0^{+\infty} W_f(a,b) \psi_{a,b} dadb . \tag{4}$$

Typically, we need to discretize the above function in real world implementation. Here we use binary discretization. Let $a = 2^m$, $b = k2^m$:

$$\psi_{m,k}(x) = \frac{1}{\sqrt{2^m}}\psi(2^{-m}x - k) \qquad (m, k \in Z^2) \quad . \tag{5}$$

Consider a continuous and square integrable function $f(x) \in L^2(R)$, it approaches to $f_m(x)$ with a resolution level of 2^m. From multiresolution analysis [9],

$$f_m(x) = \sum_{k=-\infty}^{+\infty} a_{mk}\phi_{mk}(x) \ , \tag{6}$$

where $\phi(x)$ is the scale function, and its scaling and translation produce $\phi_{mk}(x)$:

$$\phi_{mk}(x) = \frac{1}{\sqrt{2^m}}\phi(2^{-m}x - k) \qquad (m, k \in Z^2) \tag{7}$$

A typical structure of WNN is illustrated in Figure 1, which is composed of three layers: input, output and hidden layers. There are two kinds of nodes in hidden layer, that is, wavelet basis node (ψ node) and scale function node (ϕ node).

3. Related Work

Goodwill is a valuable intangible assets of companies. It is attached to the business process of companies, and plays an important role in the survival and development of enterprise. The understanding of the goodwill concept is an evolution process and some theories and practices have been accumulated.

As defined by Bourne *et al.*, [10], “goodwill may be defined as being the money value over and above the value of the actual assets of a concern (such as book debts, stock-in-trade, machinery, *etc*.) which can be realized in cases of death, dissolution, retirement, or liquidation”. Besides, George R. Catlett and Norman O. Olson [11] summarized 15 components of goodwill, and later Haim Falk and Lawrence A. Gordon [12] categorized them as four groups of 17 factors.

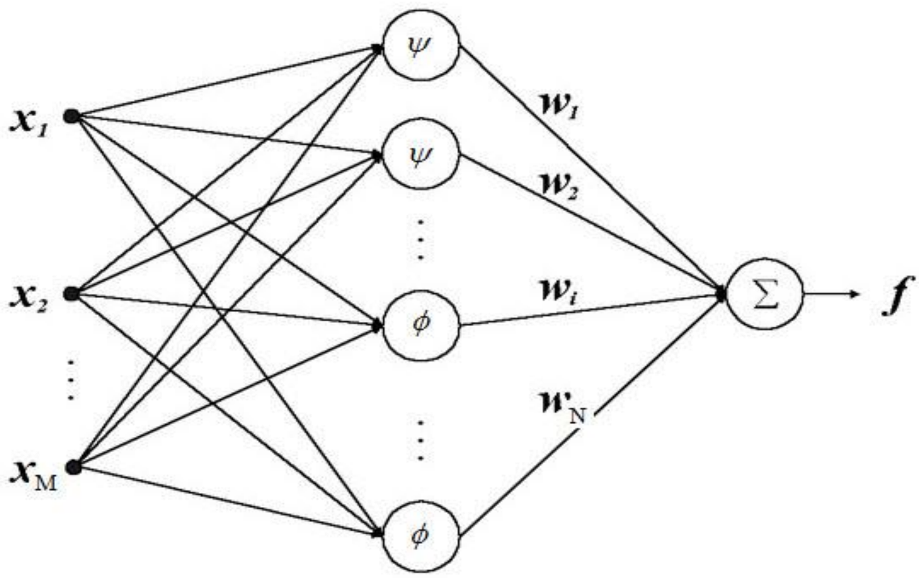

Figure 1. Framework of Data Mining System for Anti-Money Laundering

There are also some efforts on evaluating goodwill. For example, Bryan V. Carsberg [13] proposed an annuity method for goodwill valuation. Paton also [14] insisted that goodwill is the present value of the excess profits of the enterprise. Besides, Nelson [15] proposed a momentum theory, which says that "an organization desiring to enter certain activities sometimes prefers to buy a going business, that is, one which has already acquired momentum, and is willing to pay for such a business an amount in excess of the net book value of its assets". Later on, Hunter pointed out that "goodwill is the monetary value placed upon the connection and reputation of a mercantile or manufacturing concern, and discounts the value of the turn-over of a business in consequence of the probabilities of the old customers continuing" [16]. Penman [17] suggested that the benefit period should be less than 20 years for goodwill valuation, because the Return On Equity (ROE) would exceed cost of equity rate if goodwill is regarded as an asset. Keith W. Chauvin and Mark Hirschey [18] confirmed the relationship between goodwill, profitability, and the market value of the firm.

As pointed out in [19], the goodwill valuation is typically done in an accounting way. As indicated in [11], significant factors associated with the goodwill value include: reputation of the product, monopolistic rights, location of the business, personal qualifications of the head of the business, possession of contracts, manufacturing efficiency, satisfactory labor or management relations, adequate source of capital, credit standing, political advantages, in general, good management, etc. Besides, L. Johnson and Kimberley R. Petrone [20] believed that goodwill can be inspected through a top-down or bottom-up method in the sense of individual factors or their combination effect. Inspired by these existing efforts, in this study, we design a multi-layer indicator system for goodwill valuation. Moreover, we propose to utilize a WNN method to calculate the goodwill value.

Table 1. Indicators of Companies' Goodwill Evaluation (Level 2)

Level	Indicator	Description
2	B1 Enterprise growth	Abilities to gain extra benefits which reflect the development and scalability of enterprises
	B2 Internal confidence	Refers to factors that are related to internal people, finance, materials as well as management
	B3 External confidence	Reflects the recognition and preference of customers, and the social image from the public

4. Designing the Indicator System

In order to combine both the quantitative and qualitative indicators, in this section we quantize all the related factors to evaluate the goodwill value.

We suppose the value of goodwill varies from 0 to 1, and the larger the value is, the more benefits companies could gain from the goodwill. We design a multi-layered indicator system. The indicator system is a ordered set of factors attached with the goodwill evaluation. Tables 1, 2 and 3 list the Level 2, 3 and Level 4 indicators, and Figure 2 illustrates the multi-layered indicator system.

Table 2. Indicators of Companies' Goodwill Evaluation (Level 3)

Level	Indicator	Description
3	C1 Internal growth	Internal factors associated with the enterprise growth
	C2 External expansion	External market factors
	C3 Personnel quality	Internal factors attached to people
	C4 financial strength	Internal factors attached to finance
	C5 Material base	Internal factors attached to materials
	C6 Management level	Internal factors attached to management
	C7 Service level	Factors to describe the service
	C8 Public effect	Factors to describe recognition and preference of customers
	C9 Social orientation	Factors to describe social image from the public

Table 3. Indicators of Companies' Goodwill Evaluation (Level 4)

Level	Indicator	Description
4	D1 Enterprise surviving life	The total lifetime of enterprise
	D2 Labor wastage index	The ratio of persons leaving within a given period
	D3 Average annual sales growth	The summary of sales growth per year divided by the number of years
	D4 Total asset growth rate	The ratio of total assets increased to the total assets at the beginning of the same year
	D5 Expected sales growth	The ratio of expected sales next year or next quarter to the sales volume this year or the quarter
	D6 Market share	The ratio of sales to that of similar products in the market
	D7 Market expansion speed	The growth rate of market sales of products or services
	D8 Market radiation	The degree of market share over the whole market
	D9 Expected market share	Expected sale ratio of similar products in market share
	D10 Hierarchical structure of professional and technical workers	Different levels of skills for professional and technical workers
	D11 Educational structure	Different levels of education
	D12 Average age	Average age of workers

	D13 Employee sick leave rate	The rate of sick leave to the whole population of workers
	D14 Employee anti-discipline rate	The rate of anti-discipline to the whole population of workers
	D15 Manager reputation	The reputation of manager
	D16 Total assets	The total assets of the enterprise
	D17 Return on total assets	The ratio of profit to total assets
	D18 Sales profit	The ratio of gross profit to net sales
	D19 Asset-liability ratio	The ratio of debt to total assets
	D20 Current ratio	The ratio of current assets to current debts
	D21 Inventory Turnover ratio	The ratio of main business costs to the average inventory balance during specific period
	D22 Turnover ratio of receivable	The average number of accounts receivable into cash during specific period
	D23 Production scale of enterprises	The scalability of enterprise production
	D24 Capacity utilization	The ratio of actual production to production capacity during specific period
	D25 Advanced technology	The progressiveness of advanced technology
	D26 Commodity adaption level	The adaptedness of products to social consumer demand in terms of the degree of variety, quality, price, packaging, supply time
	D27 Brand operating rate	The ratio of brands during the whole sales operating
	D28 Labor productivity	Number of the products per unit time
	D29 Expense ratio value	The ratio of expense to the sales
	D30 Marginal efficiency of advertising	Income variation with unit increased advertising cost
	D31 Information utilization	The utilization degree of information
	D32 Regulatory coverage	The coverage rate of rules and regulations
	D33 Degree of management information	The degree of informationization in management
	D34 Rational proposals adoption rate	The rate of rational proposals being adopted
	D35 Number of Services	The number of services provided by the enterprise
	D36 Services investment rate	The rate of service projects being

		invested
	D37 Complaints satisfactory response rate	The response rate of complaints or satisfaction
	D38 Commitment compliance rate	The rate of commitments being met
	D39 Social contribution rate	The degree of social contribution
	D40 Social accumulation rate	The degree of social accumulation
	D41 Competitor imitation rate	The degree of competitor imitation
	D42 The degree of media attention	The degree of media attention
	D43 Customer Satisfaction	The degree of customer satisfaction
	D45 Customer Stability	The degree of customer stability
	D46 Laid-off workers absorption rate	The ratio of laid-off workers to the whole population of workers
	D47 Social influence	The degree of social influence
	D48 Consumers influence	The degree of consumer influence
	D49 Spiritual level	The level of spiritual civilization

5. Evaluating Goodwill by WNN Model

In this section, we present the process of goodwill evaluation using WNN model. Generally, the goodwill value is calculated as the linear aggregation of a set of wavelet basis. That is,

$$\hat{Y} = \sum_{i=1}^{n_1} W_i \psi(\frac{x_i - b_i}{a_i}) + \sum_{i=1}^{n_2} W_i \phi(\frac{x_i - b_i}{a_i}) , \qquad (8)$$

where n_1, n_2 is the number of ψ and ϕ nodes, and W_i is the weight of i-th wavelet basis. The values of a_i, b_i, W_i, N are all learned through WNN. The learning process can be summarized as follows.

Step1: initialize parameters a_i, b_i, W_i;

Step2: feed input samples $x_{kj} (k = 1,2,..., Q; j = 1,2,..., M)$, where Q is the number of training samples, and M is the number of indicators.

Step3: learning stage of WNN, and the goodwill is calculated as Equation (8).

Step4: optimize the minimum mean square error (MMSE) using a gradient descent method, where the optimization function is:

$$\frac{1}{Q} \sum_{k=1}^{Q} (Y_k - \hat{Y}_k)^2 \qquad (9)$$

Let η be the learning factor, and α is the momentum factor. The updates of each iteration would be as follows:

$$W_i = W_i - \eta \frac{\partial E_Q}{\partial W_i} + \alpha \Delta W_i \qquad (10)$$

$$a_i = a_i - \eta \frac{\partial E_Q}{\partial a_i} + \alpha \Delta a_i \quad (11)$$

$$b_i = b_i - \eta \frac{\partial E_Q}{\partial b_i} + \alpha \Delta b_i \quad (12)$$

Step5: when the MMSE is smaller than a threshold value or a maximum number of iterations exceed, the process stops and return all optimal parameters. Otherwise, loop from Step 2 to Step 4.

6. Experiments

In our experiments, we select a sample of presses listed on network of Press and Publication Statistical .We have 104 presses in total. Our datasets are collected from State Administration of Press, Publication, Radio, Film and Television of The People's Republic of China, website of each press and China Securities Market and Accounting Research (CSMAR) database.

The goodwill value of press Y_k is set as the difference between market value and book value of net assets. We use the first ten iterations as training stage, and the 11th and 12th iterations for prediction. Table 4 gives the results of estimation $\hat{Y}_k$ using BP neural network and WNN models. We can observe that our method with WNN model for evaluating goodwill value for companies outperforms the BP neural network. The average prediction error is 0.385% compared to 3.15% for the BP neural network method. The results show that WNN is more suitable for goodwill evaluation in both accuracy and convergence speed.

Besides, the weights for our indicator systems are learned by WNN model, as shown in Table 5.

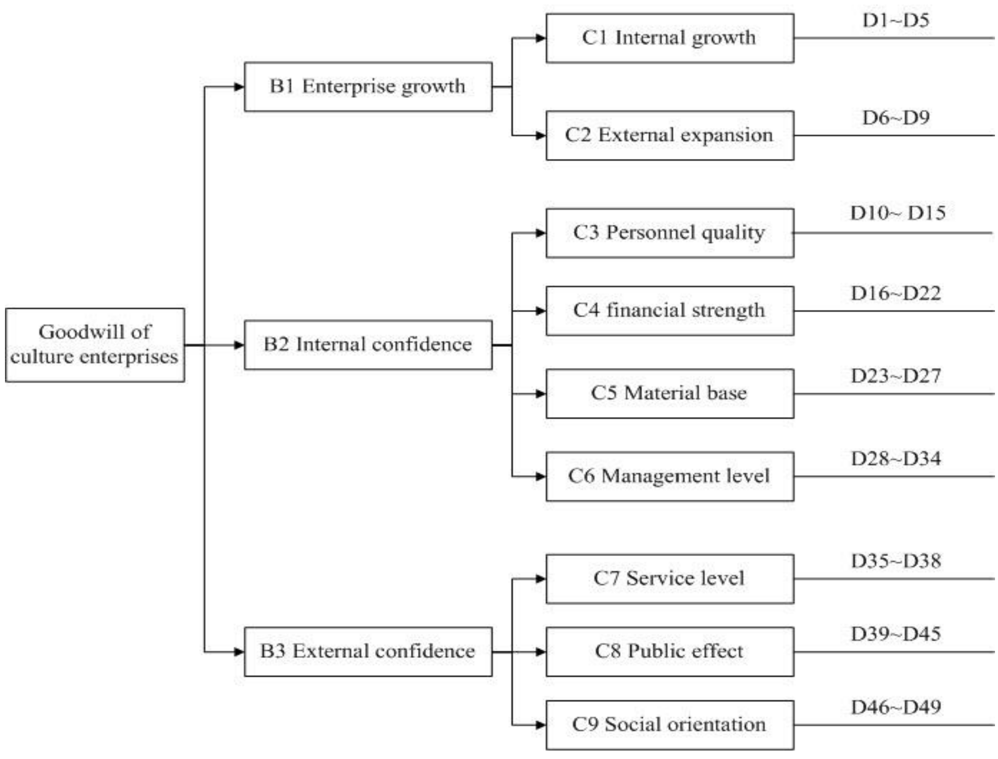

Figure 2. The Indicator System of Goodwill Evaluation

Table 4. Comparison of Prediction Errors

Model	11th estimation	12th estimation	Average	Number of iterations till convergence
BP neural network	3.8%	2.5%	3.15%	1410
WNN	0.56%	0.21%	0.385%	320

Table 5. Comparison of Prediction Errors

Level 1	Weight	Level 2	Weight	Level 3	Weight
B1	0.37	C1	0.59	D1	0.21
				D2	0.17
				D3	0.21
				D4	0.20
				D5	0.21
		C2	0.41	D6	0.27
				D7	0.25
				D8	0.24
				D9	0.24
B2	0.32	C3	0.21	D10	0.18
				D11	0.17
				D12	0.16
				D13	0.16
				D14	0.15
				D15	0.18
		C4	0.26	D16	0.15
				D17	0.17
				D18	0.13
				D19	0.12
				D20	0.14
				D21	0.15
				D22	0.14
		C5	0.27	D23	0.19
				D24	0.19
				D25	0.20
				D26	0.21
				D27	0.21
		C6	0.26	D28	0.13
				D29	0.16

				D30	0.13
				D31	0.16
				D32	0.14
				D33	0.15
				D34	0.13
B3	0.31	C7	0.34	D35	0.26
				D36	0.24
				D37	0.23
				D38	0.22
		C8	0.33	D39	0.12
				D40	0.13
				D41	0.13
				D42	0.14
				D43	0.16
				D44	0.16
				D45	0.16
		C9	0.33	D46	0.29
				D47	0.23
				D48	0.26
				D49	0.22

7. Conclusion

In this paper, we focus on the problem of valuation goodwill of culture industries. Typically, the valuation of goodwill involved two steps. First, a set of factors associated with the goodwill valuation should be abstracted. Second, above factors should be integrated with a proper method. However, the learning process of how to integrate multiple factors to more precisely value the goodwill is a big challenge. Along this line, with a multi-layer indicator system which integrates various factors, we utilize a Wavelet Neural Network (WNN) method to learn the weights of different indicators, and then calculate the goodwill value. In order to evaluate our method, we collect a sample dataset of press enterprise. The results prove the feasibility and efficiency of proposed solution.

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Authors

Han Dong Ping, She got a Bachelor of Accounting Degree (1990) in Dongbei College of Finance & Economics, then a Master's degree in Thermal engineering in Harbin Institute of Technology (1994), and a Doctoral of Accounting Degree (2002) in Harbin Institute of Technology. She studied first at Hong Kong University of Science &Technology in1997, and then enrolled at Finland Lappeenranta Industrial Technology University in 1998. She was a teacher in College of Management, a graduate and doctoral tutor in Harbin Institute of Technology between 1987 and 2005. In 2005, she worked as a Deputy Division Chief in finance department and the dean of School of Economics and Management in Weihai at the Harbin Institute of Technology in 2012.

Bao Di. She received the Master of Management in Public Administration (2010) from Yanshan University. Now she is majoring in PhD of Management in management Department from Harbin Institute of Technology University. Her current research interests include different aspects of Valuating Goodwill of Cultural enterprises Using Wavelet Neural Network.