The real estate enterprise performance evaluation model study empirical research on the real estate enterprise statistics in China: 2009-2013

Shubing Qiu

School of Management Engineering, Anhui Polytechnic University, Wuhu, China

Corresponding auhtor's e-mail: 44528934@qq.com

Received 1 November 2013, www.cmnt.lv

Abstract

Based on our real estate business development, for the shortcomings of traditional performance evaluation methods, combined with hierarchical fuzzy neural network evaluation method, using BP neural network training corporate financial indicators, and fuzzy neural network training non-financial indicators, and then to build a fuzzy neural network evaluation model integratedly, so the value of enterprise performance evaluation results can be calculated. The results show: the model is of high accuracy, which can more accurately reflect the performance of the real estate development business.

Keywords: fuzzy neural network, BP neural network, real estate business, business performance

1 Introduction

Real estate business is engaged in real estate development and management activities of a comprehensive industry, which has a pilot, basic, driven and risk characteristics, on the one hand, the real estate industry as a new growth point of macro-economic development for the domestic economy rapid growth, driven by the joint development of other related industries made a significant contribution. On the other hand, due to the lack of current evaluation system and the imperfect overall evaluation of the performance of real estate development, these factors result in the development of the domestic real estate disorder. Therefore, it is necessary to select the scientific method to construct performance evaluation model to reflect the status of the real estate business development, which is an important content.in the study of sustainable development in the real estate industry.

2 Problem statement and preliminaries

In the previous literatures, the research on the real estate enterprise performance evaluation model are focused only on selected indicators for economic analysis, research methods, mainly using the traditional balanced scorecard method, principal component analysis, composite index, efficacy coefficient method, factor analysis, economic Value Added (EVA), etc. [1], but most of these methods are of "subjective factors affecting large, poor accuracy", In addition, in the selection of indicators, only the financial indicators (quantitative indicators) are considered, while ignoring some of the non-financial indicators (qualitative indicators) and lacking accuracy and implement on the research results. Therefore, to establish a comprehensive and objective performance evaluation system can provide a strong basis for the adjustment of corporate strategy, then the implementation effect of the enterprise development strategy can be evaluated timely.

Based on this, now to select the fuzzy neural network method to evaluate the development status of the real estate enterprise performance in China. And because the fuzzy neural network, fuzzy logic and neural networks combined, can form a better system than a single fuzzy neural network system or a separate system, its operation process is not black-box operation [2, 3], so it can more efficiently and accurately reveal the development of China's real estate enterprise performance.

3 A fuzzy neural network structure selection

In the selection of neural network model based on Takagi-Sugeno (TS model for short) is blurred by the first member of the network structure of the network. And the network is consisted of two parts, of which the first network element is to match the fuzzy rules the antecedent of the network and the last to generate fuzzy rules. Its fuzzy neural network structure is simpliy shown in Figure 1.

As is shown in Figure 1, layer 1 is the input layer, and this layer is expressed as the number of nodes $N_1 = n$.

Layer 2 is the fuzzy layer, and the layer number $N_2 = \sum_{i=1}^{n} m_i$ (Now the membership function can be calculate by the Gaussian Gauss function method).

Layer 3 is the rule based reasoning layer, the total number of nodes in this layer N_3 =m.

Layer 4 is the normalized layer and the number of nodes in this layer $N_4=N_3$=m, which implements the normalization calculation and it is calculated as shown in Equation (1).

$$\bar{a}_i = a_j / \sum_{i=1}^{m} a_i,\ j = 1,2,\ldots,m. \quad (1)$$

Layer 5 is the output layer. Take the enterprise performance value as the output value of fuzzy neural network, which is calculated as shown in Equation (2).

$$y_1 = \sum_{j=1}^{m} y_{1j}\, \bar{a}_j \,. \tag{2}$$

Among them:

$$y_{1j} = p_{j0}^1 + p_{j1}^1 x_1 + p_{j2}^1 x_2 + ... + p_{jn}^1 x_n,\ j = 1,2,...m\,,$$

which p_{ji}^1 is the connection weights, the total number of nodes in this layer, N_5=1.

4 Learning algorithm selection

As is shown in Figure 1, the choice of fuzzy neural network is essentially a multilayer before-feed-forward networks, and the error back propagation algorithm can be used to adjust the parameters, which is mainly to adjust p_{ji}^1 (the connected weight of Layer 5 and the membership parameters value c_{ij} and the width σ_{ij} (i=1,2,....,n, j=1,2,....,m_i) of Layer 2 .

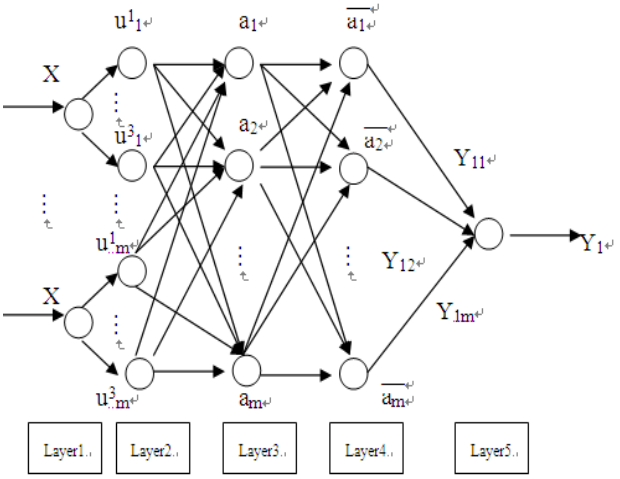

FIGURE 1 The fuzzy neural network structure based on T-S model

Assuming the input of the neurons node j in the fuzzy neural network layer q is

$$f^{(q)}(x_1^{(q-1)}, x_2^{(q-1)}, ...y^{(q-1)}{}_{nq-1}, y_{j1}^{(q)}, y_{j2}^{(q)}, ..., y_{jnq-1}^{(q)})$$

the output is $x_j^{(q)} = g^{(q)}(f^{(q)})$, then the function of each node can be expressed as:

Layer 1:

$$f_i^{(1)} = x_i^{(0)} = x_i,\ \ x_i = g_i^{(1)} = f_i^1,\quad i = 1,2,..n\,.$$

Layer 2:

$$f_{ij}^{(2)} = -(x_1^{(1)} - c_{ij})^2 / \sigma_{ij}^2 x_{ij}^{(2)} = u_i^j$$

$$= g_{ij}^{(2)} = e^{f_{ij}^{(2)}} e^{-(x_i - c_{ij})^2 / \sigma_{ij}^2},$$

$$i = 1,2,...n,\ \ j = 1,2,...m_i$$

Layer 3:

$$f_i^{(3)} = x_{1i_1}^{(2)} x_{2i_2}^{(2)} ... x_{ni_n}^{(2)} = u_1^{i_1} u_2^{i_2} ... u_n^{i_n} x_j^{(3)} = a_j = g_j^{(3)} = f_j^{(3)}$$

$$j = 1,2,...,m$$

Among them, $m = \prod_{i=1}^{n} m_i$.

Layer 4: $\bar{a}_j$

$$f_j^{(4)} = x_j^{(3)} / \sum_{i=1}^{m} x_i^{(3)} = a_i / \sum_{i=1}^{m} a_j x_j^{(4)} = \bar{a}_j = g_j^{(4)} = f_j^4,\ j = 1,2,...,m$$

Layer 5:

$$f_1^{(5)} = \sum_{j=1}^{m} y_{1j} x_j^{(4)} = \sum_{j=1}^{m} y_{1j} \bar{a}_j x_1^{(5)} = y_1 = g_1^{(5)} = f_1^{(5)}$$

Assuming the square error function is

$$c_{ij}(k+1) = c_{ij}(k) - \beta \frac{\partial E}{\partial c_{ij}},$$

$$i = 1,2,...n,\ \ j = 1,2,...m_i$$

(in which t_1 represents the expected output and y_1 represents the actual output), to adjust p_{ij}^1, c_{ij} and σ_{ij} according to the BP algorithm (error back-propagation algorithm), and then according to the learning algorithm of parameters p_{ij}^1 (as is shown in Equation (3) and Equation (4)), to adjust c_{ij} and σ_{ij} fixing the parameters p_{ij}^1, then can obtain:

$$c_{ij}(k+1) = c_{ij}^{(k)} - \beta \frac{\partial E}{\partial c_{ij}}$$

$$\sigma_{ij}(k+1) = \sigma_{ij}^{(k)} - \beta \frac{\partial E}{\partial \sigma_{ij}}, i = 1,2,...,n,\ j = 1,2,...,m_i$$

(β is the learning rate， and β >0)

$$\frac{\partial E}{\partial p_{ji}^1} = \frac{\partial E}{\partial y_1} \frac{\partial y_1}{\partial y_{1j}} \frac{\partial y_{1j}}{\partial p_{ji}^1} = -(t_1 - y_1)\, a_j\, x_i \tag{3}$$

$$p_{ji}^1(k+1) = p_{ji}^1(k) - \beta \frac{\partial E}{\partial p_{ji}^1}, i = 1,2,...,n;$$

$$j = 1,2,...,m \tag{4}$$

5 Build performance evaluation model of the real estate enterprises in China

5.1 SELECT THE INDEX SYSTEM

Performance evaluation is currently used by the majority of the real estate business for financial indicators (quantitative indicators), which select a single indicator, lack industry-specific and can not fully and objectively reflect the performance level of the real estate enterprise development

[4]. For example, the current domestic real estate companies on the Top 50 rankings, are most ranking in index selection process based on sales revenue index focused solely on the growth of "quantity", which does not combine our real estate with the ubiquitous "development disorder, housing vacancy rate increases, "and so on, and ignore the Chinese real estate industry's increase of " quality ", as is shown:

1) Lack indicators of intangible assets and intellectual capital. The current development of the individual real estate businesses are of great differences, which develop extensively and disorderly. So in the current era of knowledge and economy, we must increase the index reflects the value of intangible assets and intellectual capital, in order to measure the lasting vitality of enterprises effectively.

2) Lack indicators of reflecting environmental costs. Real estate development is taken as a modern city in the largest project land use area, and also as the city's main construction contents, which consume large amounts of energy and resources [5] and also affect the ecological quality of life of residents and the city. Thus, environmental indicators and environmental cost accounting must be increased for the real estate development performance.

5.2 IDENTIFICATION AND ANALYSIS ON THE INDICATOR OF THE REAL ESTATE ENTERPRISE PERFORMANCE EVALUATION

Enterprise performance is a very complex system, which involves a number of factors, with the multiplicity and complexity of other features, this combination of the characteristics of the real estate index design, which includes both financial indicators (quantitative indicators), but also contains the non-financial indicators (qualitative indicators). Basing on the real estate enterprise statistics in China from 2009 to 2013, to integrate select three areas of "social, economic and environmental" comprehensive estimates, expectations of the business as a whole in order to compare the performance of accurate evaluation, the specific contents of each indicator, as shown in Table 1.

TABLE 1 Indicators of the real estate enterprise performance evaluation

Financial Indicators				**Non-financial indicators**
Social Indicators	Financial Indicators	Environmental Indicators	Development capacity indicators	
X1: Per capita living space	X5: Real estate added value	X9: The growth rate of agricultural land expropriated area	X13: Capital accumulation rate	X16: Enterprise infrastructure management level
X2: Complete housing rate residential	X6: The growth rate of real estate practitioners	X10: Real estate development of residental green coverage	X14: Total asset growth	X17: Value of identity in the post
X3: The residents' average living area	X7:Ratio of real estate value added and GDP	X11: Construction waste and sewage emissions	X15: Operating profit growth	X18: Consumer satisfaction
X4: Ratio of housing price and income	X8: Real estate price index	X12: Effective utilization of land	——	X19: Real estate business brand influence

5.3 SYSTEM TEST AND SIMULATION TRAINING

Since the number of fuzzy rules with fuzzy neural network input dimension increases exponentially，so when the input level increase in the number of large, the network-structural will inevitablely be more complex and the training learning time will be longer [6], in order to solve this problem, and to minimize the influence of subjective factors on the evaluation results, there to adopt the layered-in-order-evaluation method based on the use of hierarchical fuzzy neural network, and firstly BP neural network can be used in the financial indicators simulated training, and the fuzzy neural network can be used in non-financial indicators simulated training. And then to use the fuzzy neural network to train on their results again, and come up with a final evaluation results. Set for the final evaluation result as Y→ Z={excellent, good, fair, poor}. Among them, Y is the final output of the fuzzy neural network, Z is the corresponding grade of the enterprise performance evaluation.

This paper uses batch-training methods and LM learning algorithm to calculate, and the financial indicators of BP neural network is constructed with three-tier network structure, in which the input layer neurons is 15, the output layer neuron number is 1 (the output is of the level of the financial grade of the enterprise), the hidden layer neurons number is 10 (determined according to Kolmogorov theorem), and at this time BP neural network training error is of the minimum value and shortest training time (its training error curve shown in Figure 2, where performance is 0.000895863, goal is 0.001).

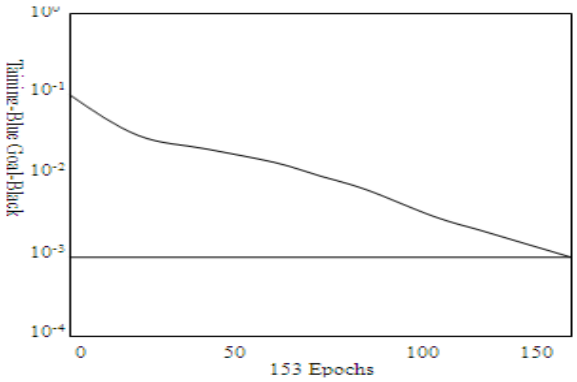

FIGURE 2 RMSE change curve in training process

The non-financial indicators of fuzzy neural network model structure is a made by 4 non-financial indicators as input, 1 output, and fuzzy layer has 16 neurons, the number of fuzzy rules is 256; the final fuzzy neural network model structure includes 2 inputs (Level results of the financial and non-financial status), 1 output (the final results of the enterprise performance evaluation), and the fuzzy layer contains 8 neurons, and the fuzzy rules is 16 (its training data mean square error curve shown in Figure 3). From Figure 3, we can see that the mean square error curve of the training data is relatively smooth, the network training is valid.

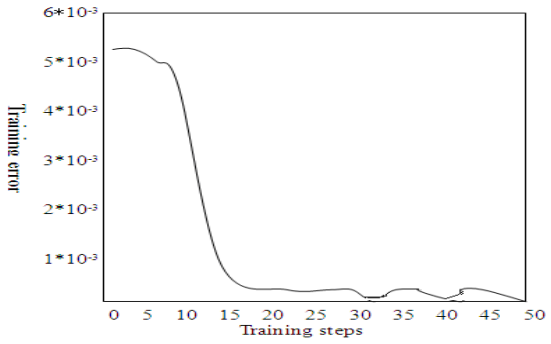

FIGURE 3 Mean square error of the training data curve

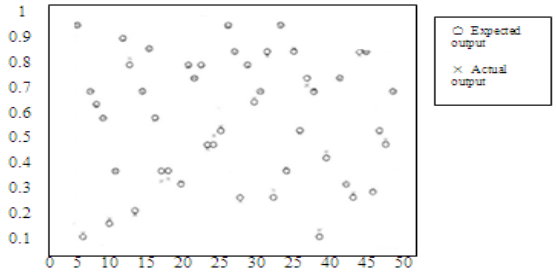

FIGURE 4 The predicted and expected output of the models

Finally, to put the test sample in the well-trained fuzzy neural network to carry out the results of the enterprise performance evaluation when the fuzzy neural network training is completed. The test results expected output and the actual output of the network are shown in Figure 4. From Figure 4, there can seen that the fuzzy neural network model we have structured in this article, which can build a completed better business performance evaluation, and the error of its network between the predicted output and the expected output is tiny, and the degree of match is up to 90%, so it is of higher accuracy.

6 Conclusions

Above all, fuzzy neural network evaluation model constructed in this paper can better solve the unshaped, nonlinear and other issues, which has parallel computing, distributed information storage, fault-tolerant capability, adaptive learning function and other advantages. And we can draw a conclusion that it is suitable for the actual developing stastus of the real estate in China. It also can provide reliable performance information for the business owners, creditors, small investors and other stakeholders who are involved in real estate, and it can effectually reduce the investment risks of the real estate market in China.

Acknowledgements

This work is partially supported by the National Foundation of Social Science of China (NO. 14BGL163) and the National Foundation of Natural Science of China (NO. 71171002). The authors also gratefully acknowledge the helpful comments and suggestions of the reviewers, which have improved the presentation.

References

[1] Peng Z 2007 A Fuzzy Neural Network Evolved by Particle Swarm Optimization *Journal of Harbin Engineering University* **3** 316-21
[2] Cao Y 2011 An Approach of C2C E-commerce Consumer Community Classification Based a Modified Fuzzy Neural Network *Journal of Computational Information Systems* **16** 5738-45
[3] Zhou X 2013 Attern Recognition Based on Fuzzy Neural Network with Improved Structure and Learning Algorithm *Journal of Computational Information Systems* **3** 1103-11
[4] Jyh J, Roger S 1993 ANF IS: Adaptive Network based Fuzzy Inference System *IEEE Transactions on Systems, Man and Cybernetics* **3** 665-85
[5] Liu K 2013 Energy Efficient Heterogeneous Network Selection Method Based on Fuzzy Neural Network*Journal 5of Information and Computational Science* **10** 3373 - 85
[6] Wei J J 2010 Research on a Fuzzy Neural Network Based Enterprise Performance Evaluation Approach *Shandong Science* **1** 36-41

Author

Shubing Qiu, born on October 18, 1980, Shandong Province of China

University studies: M.S. in 2006 and currently in College of Management Engineering at Anhui Polytechnic University (Wuhu).
Scientific interest: enterprise application integration and distributed systems.