Asian Social Science; Vol. 12, No. 6; 2016
ISSN 1911-2017 E-ISSN 1911-2025
Published by Canadian Center of Science and Education

The Investigation and Comparison of the Performance of Heuristic Methods in the Prediction of the Type of Auditor's Opinion in Firms Accepted in Tehran Stock Exchange

Nasim Nasirpour[1], Alireza, Mazdaki[2] & Esmail Enayati[3]

[1] Department of Management, College of Management, Islamic Azad University of Firouzkoh, Firouzkoh, Iran

[2] Department of Management, College of Management, Islamic Azad University of Qazvin, Qazvin, Iran

[3] Department of Accounting, College of Accounting, Islamic Azad University of Qaemshahr, Qaemshahr, Iran

Correspondence: Nasim Nasirpour, Department of Management, College of Management, Islamic Azad University of Firouzkoh, Firouzkoh, Iran. E-mail: nasirpour223@gmail.com

Received: February 16, 2016 Accepted: March 23, 2016 Online Published: May 20, 2016

doi:10.5539/ass.v12n6p148 URL: http://dx.doi.org/10.5539/ass.v12n6p148

Abstract

Stock companies play a key role in the economy of any country and the success of these companies depends to a great degree on investors and creditors' interest who invest in them. Auditors' reports assume a special position in the decisions taken by investors and creditors. Therefore, the importance of offering high quality information with a view on recent events in the firms (bankruptcy and dissolution, financial scandals, loses suffered by creditors, etc.) becomes clear; moreover, audit reports can prevent these events by creating certain signals. To this end, modern heuristic methods for the prediction of the type of auditor's opinion are offered in this paper. The aim of this study is to investigate the ability of probabilistic neural network method and to compare it with artificial neural network in order to identify and predict the type of independent auditor's opinion in Iran in the time period of 2009 to 2013. The patterns used to predict the type of independent auditor's opinion can be divided into different categories-these categories are becoming more complex and more advanced: single-variable models, multi discriminant analysis, regression function, neural networks, etc. neural networks are getting increasing popularity among researchers for their non-linear and non-parametric properties. Therefore, modern approaches are used in this study to predict the type of auditor's opinion.

Keywords: probabilistic neural networks, artificial neural networks, auditor's opinion, Tehran stock exchange

1. Introduction

Financial prediction of firms is the issue that for several years has been of the interest of many researchers. In recent years, researches done on this issue has increased significantly. The approach has moved from single-variable analysis in the 1960s to the use of advanced optimization algorithms such as artificial neural networks, genetic algorithm and many other optimization algorithms that come into handy in this case (Beaver, 1996)

Recent studies on Artificial Neural Networks (ANN) have proved that ANNs are powerful tools for the identification and classification of patterns because of their non-linear, non-parametric, and comparative learning properties. ANNs are used in the solution of many financial problems including the prediction of auditor's opinion (Lee et al., 1996).

Neural networks have been adopted in different commercial uses such as prediction of financial failure, credit rating, bond rating, prediction of future prices, and financial statement analysis. However, despite the vast use of neural networks in different commercial settings, the bulk of literature in the field has been devoted to financial failures. The common point of all studies done on the use of ANN in the predictions is the issue of teaching neural networks, where all researchers have used Back-Propagation (BP) algorithms (Yang et al., 199).

One of the most important ways of increasing efficiency and effectiveness in auditing is the adoption of modern methods of data mining in order to identify and predict the type of auditor's opinion. For this reason, there is an increasing interest to develop intelligent dynamic systems free of pattern which are based on empirical data. Neural networks are included in such dynamic system that transfers the knowledge hidden in the data to the

network structure through empirical data processing. Probabilistic Neural Networks (PNNs) as a replacement for ANNs have at their disposal a combination of computational power and flexibility of artificial intelligence while maintaining their simplicity and efficiency (Specht, 1990). One of its advantages over other models of neural networks is its easy learning and testing of results; moreover, in contrast to other models, there's no need to identify and prepare its different parts for teaching. Caldron and Chen (2002) have stated that advantages of PNNs have made them attractive as a potential replacement in auditing researches. However, they have been used in quantitative financial researches. Previous researches on the use of neural networks in auditing have focused mostly on the investigation of effectiveness of ANNs (Pour Heidari, 2010; Bagher Pour & Lashani, 2012) and less attention has been paid to other models of neural networks. The present paper claims to be the first research in Iran to compare the abilities of ANN with PNN for the identification and prediction of independent auditor's opinion.

Both PNN and ANN are kinds of data mining techniques. Due to the fact that PNN has not been used yet for the prediction of audit's reports and international researches on this issue is relatively few (Gaganis, 2007) and most of them have been devoted to ANNs, in the present research results and models achieved by using both ANN and PNN are compared and a model with the highest ability (strength) have been chosen for the prediction of audit's next year report. In other words, for the first time in Iran, the performance of PNNs is compared with that of ANNs for the identification and prediction of the type of auditor's opinion.

2. Literature Review

In 1992 Tom & Kiang compared different neural networks using linear discriminant analysis, logistic regression analysis, k nearest neighbor model, and decision tree model. For the purpose of their research they used data from 59 bankrupt banks and 59 non-bankrupt banks between 1985 and 1987 adapted based on factors such as value of assets, the number of branches and their active period. Findings of their study showed that neural networks models works better than other models.

Yang et al. (1999) used data from 220 firms to offer a model for predicting financial crisis using multilayer perceptron model. They analyzed their sample population by adding the ratio of current assets to current debts to variables suggested by Altman (1968) and considering direct and indirect effect of inputs on the output. Results of their study showed that overall accuracy of neural networks in prediction is more than logistic regression analysis. In a similar comparison by Fletcher and Goss (1993), it was proved that neural networks offer more accurate prediction than logit model.

Spathis (2003) adopted the least square method and logistic regression to investigate the effect of legal claims and financial information on audit's conditioned report using a sample of 100 Greek firms. He concluded that legal claims and financial crisis are the factors affecting issuance of conditioned report. The accuracy of his model to predict the type of auditor's opinion was 87 percent.

Anandarajan et al. (2004) used hybrid genetic-neural model, neural network, and MDA to analyze the firms chosen from among different industries. They showed that out of 5 factors adopted as inputs, hybrid genetic-neural model proved to have the highest accuracy.

In 2005 Lee et al. compared supervised and unsupervised neural networks in predicting bankruptcy. They used BP algorithms and Kohonen algorithms as representatives of supervised and unsupervised algorithms, respectively. They have adopted Altman's variables of financial crisis. The sample population include 133 pairs of bankrupt and healthy firms accepted in South Korean stock exchange. Lee et al (2005) found that BP algorithm worked better than that of Kohonen.

Doumpos et al. (2005) adopted support vector machine in a sample including 1754 British firms in the period of 1998 to 2003 to create linear and nonlinear models for the prediction of the type of auditor's opinion. They concluded that nonlinear models are better than linear models for this purpose.

Pasiouras et al. (2006) used multiple-group hierarchical discriminant model to predict the type of auditors' opinions. Their sample included 823 firms in the time span of 1998 to 2003. They used discriminant and logistic analyses for comparison and concluded that the ability to predict of multiple-group hierarchical discriminant model is more than other models.

In a research by Gaganis et al. (2007) in which 881 British firms were chosen from 1997 to 2004, the ability of PNN method to predict auditor's opinion was investigated. The results showed that the abovementioned method has the potential needed for prediction. It was also shown that it is a better model compared with ANN and logistic regression analysis.

Gaganis et al. (2007) investigated the efficiency of the nearest neighbor method in creation of models by which

to predict auditor's opinion and compared it logistic regression and linear discriminant analysis. The sample population included 5276 firms. They found that the nearest neighbor method was more efficient than the other two methods.

Fotios et al. (2007) used three data mining methods including multilayer perceptron, decision tree, and Bayesian network in a sample of 450 Irish and British firms to classify auditors' opinions. The results indicated that Bayesian network had a better function compared to other methods.

Zodolsk and Jagrick (2011) used a sample of 530 British and Irish firms to offer a model for the prediction of audits' conditioned reports; they evaluated it using a diagram of operational properties and classification costs. They concluded that using audits' conceptual preferences for the evaluation of model's performance is sufficient.

Sajjadi et al. (2007) investigated the factors affecting audit's conditioned reports using data from 144 firms between 2001 and 2004. Results of their study based on logistic regression and independent Chi-Square Test indicated that from among analyzed variables, the ratios of current and received accounts to the assets are effective on audit's conditioned report. Moreover, it was shown that last year's conditioned report and the type of auditing institution had a meaningful relationship with current year's conditioned report.

Setayesh and Jamalian Pour (2009) used data from 89 firms between 2002 and 2006 to investigate the relationship of 14 financial variable and 2 non-financial variables with the type of auditor's opinions. They achieved an acceptable opinion with the help of logistic regression analysis to 76.2 percent of a model containing 7 financial and non-financial variables.

Mkkian and Salimi Takallu (2009) adopted 5 Altman's suggested variables (1966) to predict financial crisis in 40 pairs of healthy and bankrupt firms in Kerman province. In their research the accuracy of the model had been estimated 100 percent and their model, being taught using BP algorithm, could accurately predict all healthy and bankrupt firms. Still in another research done by Makkian et al (2010), neural networks are compared with other predictive models such as discriminant analysis and logistic regression. The results of this study also showed that neural networks are best suited for prediction.

Pour Heidari and Azami (2010) identified the type of auditors' opinions using neural network and logistic regression. They used data from 1018 observations between 2000 and 2007 and proved high ability of neural networks in identification and prediction of the type of auditor's opinion. This method had an accuracy of 87.75 percent and worked better than logistic regression analysis.

Since teaching neural networks and optimizing their functions need many patterns, Abdi Pour et al (2012) used data from bankrupt firms in Tehran stock exchange in the time span of 2001 to 2009. The performance of MLP, taught by BP algorithm, was estimated 80.9 percent.

According to the literature review and theoretical framework, the following hypotheses are formulated:

H0: The ability of PNNs to predict the type of auditor's opinion compared with that of ANNs has no difference.

H1: The ability of PNNs to predict the type of auditor's opinion compared with that of ANNs is better.

3. Research Method

Due to the fact that current research will use data mining process, steps taken in the research and the way they are performed will match Cross Industry Standard Process for Data Mining (CRISP-DM). CRISP-DM process is a standard data mining method created in 1996 by three big companies: Daimler Chrysler (later changed to Daimler-Benz), SPSS, and NCR. This methodology has divided the life cycle of data mining project into 6 flexible stages including: (1) business understanding; (2) data understanding; (3) data preparation; (4) modeling; (5) evaluation; and (6) deployment.

In this research data are first analyzed and those about which there has been no knowledge are discovered and regulated. A combination of library research and field research methods is adopted for data gathering. At first library research method is used to study about the related literature and background of the subject, getting familiar with different kinds of audit's reports and adoption of ANNs. After that, data and financial ratios of studied firms are collected; Excel software was used for the summarization of data and MATLAB was finally used for the investigation of neural networks models. Detailed explanation as to the methodology is provided in chapter 3.

A neural network consists of at least three layers: an input layer from which data are entered into the network; a hidden layer; and an output layer which indicates model's output. The number of hidden layers and neurons existing in each layer is usually determined with regard to specific problems. The structure of neural network and the number of neurons are usually specified by trial and errors. After investigation of different structures, we

found that the structure of the problem in question of this research is multilayer perceptron; one input layer, three hidden layers, and one output layer. It is to be noted that input layer of this network has 6 neurons (equivalent with the number of financial ratios used in this study). Hidden layers also include 15, 10, and 1 neuron, respectively. And finally the output layer has one neuron. Moreover, template method pattern (on-line) was made use of for learning.

The function used in hidden layers of this model is Sigmoid Function which is calculated in the following way:

$$sgm(x) = \frac{1}{1+ e^{-x}} \tag{1}$$

4. Radial Basis Function Neural Network

Radial Basis Function (RBF) neural networks have powerful mathematical basis and are dependent on regulatory hypothesis for solving hard problems. Such networks usually consist of three layers: input, hidden, and output (Fig. 1). Regulated RBFs are used as the activity function of neurons in the hidden layer. This network enjoys a combination of supervised and unsupervised algorithms. In this algorithm, unsupervised algorithms like K-mean, maximum likelihood estimate technique, or self-organizing map method are used to determine the radius and the center of function. Determination of weights between hidden layer and output layer is done through the least square method and the gradient method.

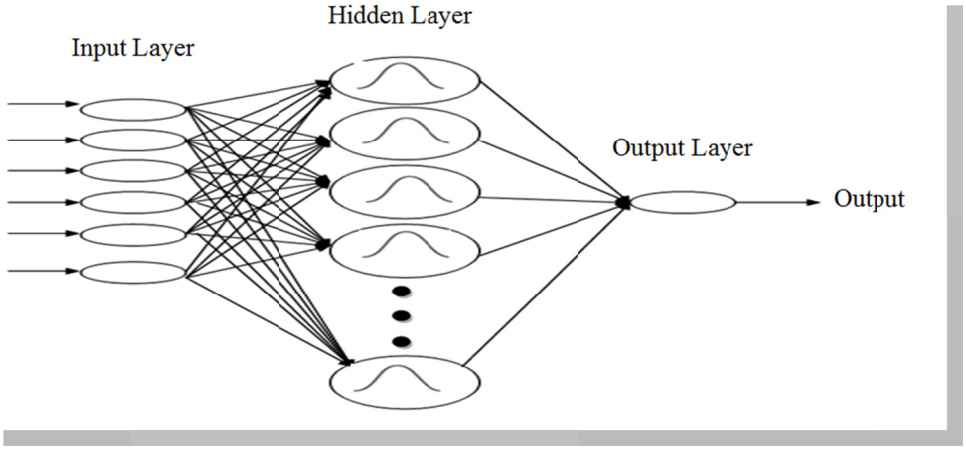

Figure 1. RBF structure

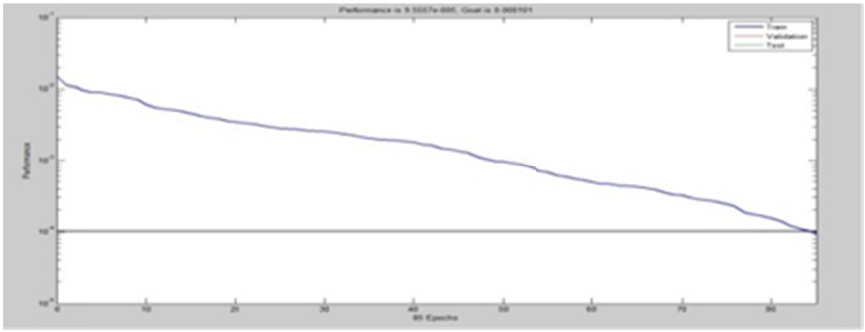

Figure 2. Error reduction in learning RBF network

For the p input algorithm, i.e. X^p, the j response of hidden layer knot, i.e. y_j, equals (2):

$$y_j = f\left(\frac{\|X^p - U_j\|}{2\sigma_j^2}\right) \tag{2}$$

in which $\|...\|$ is Euclidean norm, U_j is the center of j RBF, and σ indicates the radial distance to the

center of the function. In addition, the output of k knot i.e. Z_{pk} is calculated using equation (3).

$$Z_{pk} = \sum_{j=1}^{L} y_i w_{kj} \quad (3)$$

in which w_{kj} equals the weight of j neuron of the hidden layer and k neuron of output layer.

Error reduction in learning RBF network shown in Fig. 2 shows that adopted neural network has reached to convergence of accuracy in the 85th time. As shown in the picture, the accuracy taken to be the favorable network accuracy is $1e^{-4}$. The number of neurons in the hidden layer is equal to the number of times, i.e. 85. For the purpose of comparing the performance of the two networks, learning of both networks had been in the same degree and results are then tested. The selected accuracy is $1e^{-4}$.

5. Probabilistic Neural Networks (PNNs)

PNNs enjoy both the simplicity and transparency of traditional models of statistical classification and flexibility and computational power of BP neural networks (Specht, 1990).

A PNN can be regarded as a four-layered network. The input layer includes N neuron and N is equal to the number of input variables. Network's inputs are attached to M neuron of pattern layer. Input vector Xi whose value is1×N is processed by the function in neuron j (in the pattern layer) and the output of this neuron is obtained in the pattern layer.

5.1 Analysis of Data Mining Results

In this section, results of two data mining techniques are first compared; after that, the results of statistical survey of data (default accuracy) are compared with data mining results.

5.2 The Comparison of Accuracy Resulted from Adopting Data Mining Techniques

The accuracy models obtained from data mining techniques are comparatively presented in Table 1.

Table 1. Comparison of models' means of accuracy

Mean of accuracy		Technique
Second approach (25%)	First approach (20%)	
%85.3	%87.2	PNN
%84.3	%85.5	ANN

Information given in the above table show that models resulted from PNNs and ANNs (multilayer perceptron) have respectively the highest and the lowest accuracy in prediction of the type of independent audit's report.

6. Comparison of Data Mining Results with Default Accuracy of Statistical Population

If data mining tools are not adopted for the prediction of independent audit's report and it is predicted only be reliance on probability rules, default accuracy of dependent variable will be according to Table 2.

Table 2. Default accuracy of dependent variable in the statistical population

Total	Unacceptable report	Acceptable report	Description
1938	1359	579	Number
%100	%70	%30	Percent

The above table shows that the maximal accuracy to predict audit's report (audit's unacceptable report) using frequency of dependent variable is 70%, while the accuracy to predict audit's report using data mining process is at least 85.57%. Therefore, the accuracy of data mining process to predict dependent variable is higher than that of statistical analyses.

7. Analysis of Types 1 and 2 Risks

As it was pointed out in the chapter 1, auditors can use results of this research to reduce audit risks. Audit risk is

the probability that an auditor may issue unqualified reports. Audit risk is of two kinds: type 1 risk (alpha) means that the auditor may in case where financial statements present a desirable picture, issue unacceptable reports (rejection of valid); type 2 risk (beta) means that auditor may in cases where financial statements don't present a desirable picture, issue acceptable reports (acceptance of invalid). Therefore, in cases where audit report is acceptable but is predicted as unacceptable by the model, type 1 risk had occurred and in cases where audit report is unacceptable but is predicted as acceptable by the model, type 2 risk has occurred. It is to be mentioned that alpha risk affects efficiency of audit and beta risk affects its effectiveness (Aghai, 2006).

7.1 Type 1 and 2 Risks in ANN Technique (Multilayer Perceptron)

The following table demonstrates type 1 and 2 risks in ANN technique in the two approaches used here:

Table 3. Alpha and Beta risks in models developed by ANN technique

Predicted- second approach (25%)			Predicted- first approach (20%)			Alpha and Beta risk analysis	
Total	Unacceptable	Acceptable	Total	Unacceptable	Acceptable		
%100	%24	%76	%100	%24	%76	Acceptable	Actual
%100	%90	%10	%100	%89	%11	Unacceptable	

These results show that the ability of both models to reduce type 1 risk is equal (24%). However, their abilities differ regarding type 2 risk. In other words, type 2 risk of the model in the first approach (11%) is more than that of the second approach (10%). Therefore, the model obtained from the first approach has more ability in reducing type 2 risk.

7.2 Type 1 and 2 Risks in PNN Technique

Table 4 shows type 1 and 2 risks in PNN technique in the two approaches used here:

Table 4. Alpha and Beta risks in models developed by PNN technique

Predicted- second approach (25%)			Predicted- first approach (20%)			Alpha and Beta risk analysis	
Total	Unacceptable	Acceptable	Total	Unacceptable	Acceptable		
%100	%19	%81	%100	%19	%81	Acceptable	Actual
%100	%85	%15	%100	%91	%9	Unacceptable	

These results show that the ability of both models to reduce type 1 risk is equal (19%). However, their abilities differ regarding type 2 risk. In other words, type 2 risk of the model in the first approach (9%) is less than that of the second approach (15%). Therefore, the model obtained from the first approach has more ability in reducing type 2 risk.

8. Conclusion

In the modern economy with the increasing demand for reliable information, the need for qualified persons responsible for crediting offered reports and information is necessary. This necessity become more palpable when we look at events occurred in firms (bankruptcy and dissolution, financial scandals, loses suffered by creditors, etc.) and audit reports can create signals to prevent such events. Moreover, based on previous researches, the type and the contents of audit reports are also useful sources of information and the prediction of the type of audit report in the next year can be effective in decision making.

On the other hand, with regard to increased commercial and economic transactions and advanced information technology, financial data are quickly accumulated and this, in turn, limits the optimal and efficient use of such data. To this end, data mining techniques are adopted for the optimal and effective use of financial data in decision makings. Data mining is a process which deals with information extraction from bulky databases in a fresh way. Using a set of statistical and modeling methods, it can identify hidden patterns and relationships in the minimum time and with a high accuracy. Therefore, this study adopted "data mining classification" techniques to offer a model for "the prediction of the type of auditor's report" using firms' financial and non-financial data.

In this research we used neural networks and data from firms accepted in Tehran stock exchange in the time span

of 2009 to 2013 in order to predict audit's report. To this end, we used two different neural networks with totally different learning algorithms. In the first neural network, i.e. RBF, BP learning algorithm was used. As to the second type of neural network, PNN was adopted in which the first algorithm belonged to supervised learning algorithm and in the second algorithm, a combination of supervised and unsupervised learning algorithms are used (see chapter 3). Neural network model was created by MATLAB software. In this research, based on previous researches and Iranian Audit Standards (section 700), audit reports were classified into acceptable and unacceptable reports (including conditioned report, rejected report, and no opinion). Operational model of this research is in accordance with CRISP-DM standard.

The nature of researches done on the issue of neural networks necessitates the data to be classified into two categories. The first category is used for learning network and the second one is used for testing it. Moreover, for the investigation of the effectiveness of ratio of testing data, two categories with different ratios of learning to testing were chosen. Data of the first category were chosen randomly with 80-20 ratio and were attributed to learning and testing data. The process was repeated thrice to obviate the effect of randomization. In the second category 75% of data were attributed to learning and the rest 25% were attributed to testing. The process was repeated thrice so as to have three categories of such data.

Having taught RBF and PNN networks with an equal accuracy (1 e $^{-3}$) a four-layered structure was created. The structure of neural network adopted in this research had four layers: one input layer, two hidden layers, and one output layer. The input layer includes 13 neurons (equal to the number of inputs used in this study). Hidden layers also include 1.5, 1.10, and 1.15 neurons, respectively. And finally the output layer has 1 neuron (this structure is the result of much trial and error and after having studied different structures). Based on the findings of the research, PNN technique (first approach: 87.2%; second approach: 85.3%) and ANN technique (first approach: 85.5%; second approach: 84.3%) had respectively the highest and the lowest accuracy in prediction of the type of independent auditor's report.

References

Abdi Pour, S., Naseri, A., & Zamani, Sh. (2012). *A heuristic model for the prediction of financial crises in firms accepted in Tehran Stock Exchange* (pp. 307-319). The tenth national conference on Iranian accounting, Tehran.

Altman, E. (1968). Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance, 23*(4), 589-609. http://dx.doi.org/10.1111/j.1540-6261.1968.tb00843.x

Anandarajan, M., Lee, P., & Anandarajan, A. (2004). *Bankruptcy predication using neural networks, Business Intelligence Techniques: A Perspective from Accounting and Finance.* Germany: Springer-Verlag.

Beaver, W. (1966). Financial ratios as predictors of failure. *Journal of Accounting Research, 5*, 71-111. http://dx.doi.org/10.2307/2490171

Charalambos, S., Michael, D., & Constantin, Z. (2003). Using client performance measures to identify pre-engagement factors associated with qualified audit reports in Greece. *The International Journal of Accounting, 38,* 267-284. http://dx.doi.org/10.1016/S0020-7063(03)00047-5

Chrysovalantis, G., Fotios, P., & Michael, D. (2007). Probabilistic neural networks for the identification of qualified audit opinions. *Expert Systems with Applications, 32,* 114-124. http://dx.doi.org/10.1016/j.eswa. 2005.11.003

Fletcher, D., & Goss, E. (1993). Forecasting with neural networks: An application using bankruptcy data. *Information & Management , 24*, 159-167. http://dx.doi.org/10.1016/0378-7206(93)90064-Z

Lee, K, Booth, D, & Alam, P. (2005). A comparison of supervised and unsupervised neural Networks in predicting bankruptcy of Korean firms. *Expert Systems with Applications,* (29), 1-16. http://dx.doi.org/10. 1016/j.eswa.2005.01.004

Lee, K. (2001). *Pattern classification and clustering algorithms with supervised and unsupervised neural networks in financial applications* (Ph.D. dissertation). Kent State University.

Makkian, N., & Karimi Takalu, S. (2009). Prediction of financial crisis of manufacturing firms using artificial neural networks: A case study of firms in Kerman province. *The Quarterly of Quantitative Economy, 6*(1), 129-144.

Raghupathi, W. (1994). A neural network approach to bankruptcy prediction. *Journal of Information science and Technology,* (3), 1-14.

Raghupathi, W. (1996). Comparing Neural Network Algorithm in Bankruptcy Prediction. *International Journal of Computational Intelligence and Organizations, 1*(3), 179-187.

Sajjadi, H., Farazmand, H., Dastgir, M., & Dehghan Far, D. (2007). The factors affecting on audit's conditioned report. *The Quarterly of Accounting Studies, 18*.

Sajjadi, H., Vazra Nejad, M., & Jafari, A. (2009). Non-financial properties affecting financial reporting quality in firms accepted in Tehran Stock Exchange. *Journal and Accounting and Auditing, 57*, 51-68.

Tseng, F. M., & Hu, Y. C. (2010). Comparing four bankruptcy prediction models: Logit, quadratic interval logit, neural and fuzzy neural networks. *Expert Systems with Applications*, (37), 1846-1853. http://dx.doi.org/10.1016/j.eswa.2009.07.081

Yang, Z., Platt, M., & Platt, H. (1999). Probabilistic neural networks in bankruptcy prediction. *Journal of Business Research, 44*, 67-74. http://dx.doi.org/10.1016/S0148-2963(97)00242-7

Zhang, G., Hu, M. Y, Patuwo, B. E, & Indro, D. C. (1999). Artificial neural networks in bankruptcy prediction: general framework and cross validation analysis. *European Journal of Operational Research, 116*, 16-32. http://dx.doi.org/10.1016/S0377-2217(98)00051-4