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Modelling credit rating by fuzzy adaptive network☆

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Abstract

Human judgment plays an important role in the rating of enterprise financial conditions. The recently developed fuzzy adaptive network (FAN), which can handle systems whose behaviour is influenced by human judgment, appears to be ideally suited for the modelling of this credit rating problem. In this paper, FAN is used to model the credit rating of small financial enterprises. To illustrate the approach, the data of the credit rating problem is first represented by the use of fuzzy numbers. Then, the FAN network based on inference rules is constructed. And finally, the network is trained or learned by using the fuzzy number training data. The main advantages of the proposed network are the ability for linguistic representation, linguistic aggregation and the learning ability of the neural network.

Keywords: Credit rating; Fuzzy adaptive network; Linguistic representation; Fuzzy number; Fuzzy logic

1. Introduction

Various factors are used to determine the credit worth of a financial enterprise. Many of these factors are linguistic, vague and frequently conflicting with each other. Vagueness may be caused by many different situations such as the difficult in defining precision, in deciding which variable is important, and how to define the variables and, sometimes, even how to define the problem. Furthermore, these factors are generally dynamic and their values and relative importance are changing with time. Due to these problems, the modern computer cannot be used effectively and the judgment of human experts form an essential part of the overall evaluation.

To overcome these problems and to make the modern computer more useful, the approach must possess the following three ingredients: the ability to represent the linguistically vague information correctly, the ability to manipulate or to aggregate the represented information to obtain some reasonable results or conclusions, and the ability to improve the approximate representation as more data become available. The recently developed fuzzy adaptive networks [1–3] appear to be ideally suited to satisfy these three requirements. Fuzzy adaptive network (FAN)

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is obtained by combining fuzzy logic, which is devised both for linguistic representation and for the manipulation or aggregation using fuzzy inference, and neural network, which has the ability of learning. Thus, by the use of FAN both the improvement of the approximate representation and the dynamic nature of the system can be modelled.

Various investigators have proposed the use of fuzzy sets or neural network for credit rating. Rosenberg and Gleit [4] summarized the various quantitative methods such as Markov chains, discriminant analysis, decision trees, expert systems, the various mathematical programming methods and neural networks used in credit management. They discussed applications of neural networks to corporate credit decisions and fraud detection. Hand and Henley [5] reviewed the statistical classification methods for consumer credit scoring and suggested that neural networks are well suited to situations where we have poor understanding of the data structure. Widrow et al. [6] summarized the applications of neural network in industry, business and science. Those authors cited the use of neural network by Chase Manhattan Bank to evaluate corporate loan risk and loan approval. West [7] investigated the accuracy of credit scoring by the use of five neural network models and the results are benchmarked against the more traditional methods such as discriminant analysis, k nearest neighbour, decision trees, etc. One problem with these modelling approaches is the fact that neural networks are black box approaches and have no representative powers, so they ignore the vague linguistic nature of the problem.

To overcome the vagueness or linguistic nature, fuzzy approaches should be used. It appears that Su and Chen [8] are the earliest researchers to use fuzzy sets. Rommelfanger [9] proposed the use of fuzzy logic to check the credit solvency of small business firms. Weber [10] used fuzzy logic for credit worthiness evaluation. Syau et al. [11] used fuzzy membership function to model the credit worthiness of an enterprise. Malhotra and Malhotra [12] suggested the use of artificial intelligence, neural network and fuzzy logic to reduce the complexity and to improve the accuracy in credit rating. However, they didn't give any details or algorithms for the approach. Rast [13] used a neural fuzzy combination approach, where the fuzzy part is used as a special case of known network units such as sigmoidal and RBF neurons, to improve credit rating. Piramuthu [14] proposed to use neural fuzzy system to improve their credit evaluation decisions. The learning ability of holographic fuzzy classifier has also been suggested for use in credit scoring [15].

Except for the use of fuzzy approaches, all the other approaches mentioned above emphasize neural work learning. The traditional approaches such as these based on the general statistic concept cannot represent the linguistic expression and thus the representation is either over simplified or over represented. Although fuzzy approaches overcome this problem, pure fuzzy approaches lack the learning ability and thus cannot improve the representation as more data become available. To achieve both the learning and the representation ability, we propose the use of the relatively new fuzzy adaptive network, which is a much more powerful combination of neural network and fuzzy logic, for the modelling of credit worthiness of financial enterprises.

In the following section, based on the general practices of the banks of Taiwan [16] and our earlier results on the modelling of credit rating by fuzzy membership functions [11], the data for fuzzy logic are formulated. Then, in Section 3, the fuzzy adaptive network (FAN) is summarized. Finally, to illustrate and to show the advantages of the FAN network, numerical results are obtained and are compared with results obtained from the literature.

2. Aggregation of credit rating

To obtain the data needed, the credit rating data for small enterprises obtained from the Committee of the Banks of the City of Taipei [16] will be used. The data can be classified into three categories:

1. Financial conditions (F)
   - debt payment ability (liquidity ratios)
     quick ratio (F_1)
     current ratio (F_2)
   - financial structure ratios
     debt–liquidity ratio (F_3)
     long-term asset efficiency ratio (F_4)
   - earning ability (profitability ratios)
     interest expense to net sales ratio (F_5)
     profit margin before tax (F_6)
     return on net worth before tax (F_7)