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A practical approach to credit scoring

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Abstract

This paper proposes a DEA-based approach to credit scoring. Compared with conventional models such as multiple discriminant analysis, logistic regression analysis, and neural networks for business failure prediction, which require extra a priori information, this new approach solely requires ex-post information to calculate credit scores. For the empirical evidence, this methodology was applied to current financial data of external audited 1061 manufacturing firms comprising the credit portfolio of one of the largest credit guarantee organizations in Korea. Using financial ratios, the methodology could synthesize a firm's overall performance into a single financial credibility score. The empirical results were also validated by supporting analyses (regression analysis and discriminant analysis) and by testing the model's discriminatory power using actual bankruptcy cases of 103 firms. In addition, we propose a practical credit rating method using the predicted DEA scores.

Keywords: Data envelopment analysis; Credit scoring; Credit rating

1. Introduction

Credit scoring problems are basically in the scope of classification agenda that is a commonly encountered decision making task in businesses, and it is a typical classification problem to categorize an object into one of predefined groups or classed based on a number of observed attributes related to that object (Anderson, 1984; Chen & Huang, 2003; Dillon & Goldstein, 1984; Hand, 1981; Johnson & Wichern, 1998; Lee, Jo, & Han, 1997; Morrison, 1990; West, 2000; Zhang, 2000).

So far, a variety of methods such as linear probability and multivariate conditional probability models, the recursive partitioning algorithm, artificial intelligence approaches, multi-criteria decision-making (MCDM), mathematical programming approaches have been proposed to support the credit decision (Bryant, 1997; Butta, 1994; Coakley & Brown, 2000; Davis, Edelman, & Gammerman, 1992; Dimitras, Slowinski, Susmaga, & Zopounidis, 1999; Emel, Oral, Reisman, & Yolalan, 2003; Falbo, 1991; Frydman, Altman, & Kao, 1985; Martin, 1997; Reichert, Cho, & Wagner, 1983; Roy, 1991; Tam & Kiang, 1992; Troutt, Rai, & Zhang, 1996; Zopounidis & Doumpos, 1998).

Offering financial institutions a means for evaluating the risk of their credit portfolio in a timely manner, such models can provide an important body of information to help them formulate their respective risk management strategies. In fact, banking authorities such as Bank of International Settlements (BIS), the World Bank, the IMF, and the Federal Reserve all encourage commercial banks to develop internal models to better quantify financial risks (Basel Committee on Banking Supervision, 1999; English & Nelson, 1998; Federal Reserve System Task Force on Internal Credit Risk Models, 1988; Lopez & Saidenberg, 2000; Treacy & Carey, 2000).

The purpose of this paper is to suggest a new approach to credit scoring, which is based on DEA. As opposed to well-known methods such as multiple discriminant analysis, logistic regression analysis, and neural networks, which require ex ante information of "good/bad" classification, this approach only needs ex post information of the observed set of input and output data of the objects of interest (client firms) to calculate their respective credit

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scores. With these scores, we also provide a practical credit rating method to classify client firms into several balanced classes.

2. Literature review

In the credit industry, neural networks (NN) has recently been claimed to be an accurate tool for credit analysis among others (Desai, Crook, & Overstreet, 1996; Malhotra & Malhotra, 2002; West, 2000). Desai et al. (1996) have explored the abilities of NN and the traditional statistical techniques such as linear discriminant analysis (LDA) and logistic regression analysis (LRA) in constructing credit scoring models. They claimed that NN shows a promise if the performance measure is the percentage of bad loans accurately classified. However, if the performance measure is the percentage of good and bad loans accurately classified, LRA is as good as NN. The percentage of bad loans correctly classified is an important performance measure for credit scoring models since the cost of granting a loan to a defaulter is much larger than that of rejecting a good applicant.

West (2000) has also investigated the accuracy of quantitative models commonly used by the credit industry. The results indicated that NN could improve the credit scoring accuracy. He also suggested that LRA is a good alternative to NN while LDA, k-nearest neighbor (k-NN), and CART (classification and regression tree) did not produce encouraging results. Commonly considered as a black-box technique without logic or rule-based explanations for the input–output approximation, the main shortcoming of applying NN to credit scoring lies in the difficulty of explaining the underlying principle for the decision to rejected applications.

Although NN and other traditional methods for credit scoring require ex ante information for business failure prediction, it is more useful in practice to build a credit scoring model based on ex post financial information. The idea is to develop a meaningful "peer group analysis" with specific financial characteristics that distinguish between two or more groups, and in the late 1990s, data envelopment analysis (DEA) was introduced to this peer group analysis for business failure prediction (Cielen & Vanhoof, 1999; Simak, 1992; Troutt et al., 1996).

As opposed to broadly known MDA, LRA, NN approach, DEA requires solely ex-post information, i.e. the observed set of input and output data, to calculate the credit scores. Yeh (1996) was one of the pioneers to combine DEA with financial ratio analysis. She utilized DEA to evaluate bank performance. Her study empirically demonstrated that DEA, in conjunction with financial ratio analysis, can effectively aggregate and reclassify perplexing ratios into meaningful financial dimensions, which enable analysts to gain an insight into the operating strategies of banks. Emel et al. (2003) proposed a credit scoring methodology based on DEA. Although their approach, which is applied to the limited number of Turkey's commercial banks, is not relatively delicate compared with conventional statistical analyses, it provides the base of this study.

DEA converts a multiplicity of input and output measures into a unit-free single performance index formed as a ratio of aggregated output to aggregated input. Conceptually, DEA compares the DMUs' observed outputs and inputs in order to identify the relative "best practices" for a chosen observation set. Based on these best observations, an efficient frontier is established, and the degrees of efficiency of other units with respect to the efficient frontier are measured. Therefore, in the context of credit scoring, the performance index via DEA measures the relative credit riskiness of the firms within credit portfolio (Emel et al., 2003). DEA, which computes a firm's efficiency by transforming inputs into outputs relative to its peers, may provide a fine mechanism for deriving appropriate categories for this purpose.

3. Research methodology

The research methodology consists of seven steps, as outlined in Fig. 1. The first three steps deal with selection of firms for the study and with identification of indicators that may be used to evaluate the firms' financial performance. Step 4 uses DEA to obtain credibility scores of the firms. Step 5 validates the DEA-based credibility scores by comparing them against those obtained via regression and discriminant analyses, and by using actual bankruptcy cases. Finally, Step 6 proposes a credit rating method by investigating the distribution of good/bad firms' credibility scores.

Step 1: Selection of observation set.
We select the firms applying for new credit allocation or whose credit limits is already allocated by

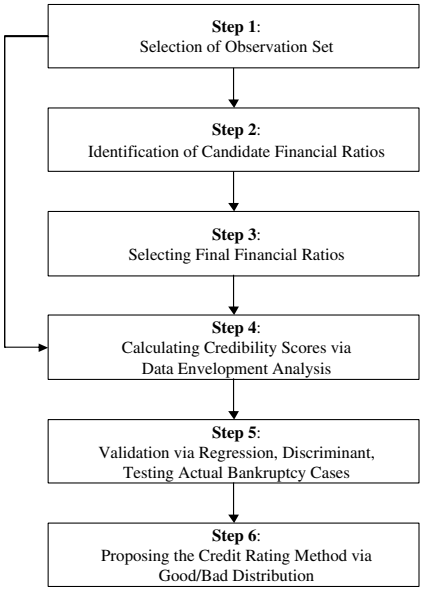

Fig. 1. Flowchart of the research methodology.