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# Credit rating analysis with support vector machines and neural networks: a market comparative study

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## Abstract

Corporate credit rating analysis has attracted lots of research interests in the literature. Recent studies have shown that Artificial Intelligence (AI) methods achieved better performance than traditional statistical methods. This article introduces a relatively new machine learning technique, support vector machines (SVM), to the problem in attempt to provide a model with better explanatory power. We used backpropagation neural network (BNN) as a benchmark and obtained prediction accuracy around 80% for both BNN and SVM methods for the United States and Taiwan markets. However, only slight improvement of SVM was observed. Another direction of the research is to improve the interpretability of the AI-based models. We applied recent research results in neural network model interpretation and obtained relative importance of the input financial variables from the neural network models. Based on these results, we conducted a market comparative analysis on the differences of determining factors in the United States and Taiwan markets.

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## 1. Introduction

Credit ratings have been extensively used by bond investors, debt issuers, and governmental officials as a surrogate measure of riskiness of the companies and bonds. They are important determinants of risk premiums and even the marketability of bonds.

Company credit ratings are typically very costly to obtain, since they require agencies such as Standard and Poor's and Moody's to invest large amount of time and human resources to perform deep analysis of the company's risk status based on various aspects ranging from strategic competitiveness to operational level details. As a result, not all companies can afford yearly updated credit ratings from these agencies, which makes credit rating prediction quite valuable to the investment community.

Although rating agencies and many institutional writers emphasize the importance of analysts' subjective judgment in determining credit ratings, many

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researchers have obtained promising results on credit rating prediction applying different statistical and Artificial Intelligence (AI) methods. The grand assumption is that financial variables extracted from public financial statements, such as financial ratios, contain a large amount of information about a company's credit risk. These financial variables, combined with historical ratings given by the rating agencies, have embedded in them valuable expertise of the agencies in evaluating companies' credit risk levels. The overall objective of credit rating prediction is to build models that can extract knowledge of credit risk evaluation from past observations and to apply it to evaluate credit risk of companies with much broader scope. Besides the prediction, the modeling of the bond-rating process also provides valuable information to users. By determining what information was actually used by expert financial analysts, these studies can also help users capture fundamental characteristics of different financial markets.

In this study, we experimented with using a relatively new learning method for the field of credit rating prediction, support vector machines, together with a frequently used high-performance method, backpropagation neural networks, to predict credit ratings. We were also interested in interpreting the models and helping users to better understand bond raters' behavior in the bond-rating process. We conducted input financial variable contribution analysis in an attempt to interpret neural network models and used the interpretation results to compare the characteristics of bond-rating processes in the United States and Taiwan markets. The remainder of the paper is structured as follows. A background section about credit rating follows the introduction. Then, a literature review about credit rating prediction is provided, followed by descriptions of the analytical methods. We also include descriptions of the data sets, the experiment results and analysis followed by the discussion and future directions.

## 2. Credit risk analysis

There are two basic types of credit ratings, one is for specific debt issues or other financial obligations and the other is for debt issuers. The former is the one most frequently studied and can be referred to as a "bond

rating" or "issue credit rating." It is essentially an attempt to inform the public of the likelihood of an investor receiving the promised principal and interest payments associated with a bond issue. The latter is a current opinion of an issuer's overall capacity to pay its financial obligations, which conveys the issuer's fundamental creditworthiness. It focuses on the issuer's ability and willingness to meet its financial commitments on a timely basis. This rating can be referred to as "counterparty credit rating," "default rating" or "issuer credit rating." Both types of ratings are very important to the investment community. A lower rating usually indicates higher risk, which causes an immediate effect on the subsequent interest yield of the debt issue. Besides this, many regulatory requirements for investment or financial decision in different countries are specified based on such credit ratings. Many agencies allow investment only in companies having the top four rating categories ("investment" level ratings). There is also substantial empirical evidence in the finance and accounting literature that have established the importance of information content contained in credit ratings. "These studies showed that both the stock and bond markets react in a manner that indicated credit ratings convey important information regarding the value of the firm and its prospects of being able to repay its debt obligations as scheduled" [28].

A company obtains a credit rating by contacting a rating agency requesting that an issuer rating be assigned to the company or that an issue rating be assigned to a new debt issue. Typically, the company requesting a credit rating submits a package containing the following documentation: annual reports for past years, latest quarterly reports, income statement and balance sheet, most recent prospectus for debt issues and other specialized information and statistical reports. The rating agency then assigns a team of financial analysts to conduct basic research on the characteristics of the company and the individual issue. After meeting with the issuer, the designated analyst prepares a rating report and presents it to the rating committee, together with his or her rating recommendations. A committee reviews the documentation presented and discuss with the analysts involved. They make the final decision on the credit rating and take responsibility for the rating results.

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