Knowledge-Based Systems 26 (2012) 259–270

Contents lists available at SciVerse ScienceDirect

Knowledge-Based Systems

journal homepage: www.elsevier.com/locate/knosys

Classifying credit ratings for Asian banks using integrating feature selection and the CPDA-based rough sets approach

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ARTICLE INFO

Article history:
Received 13 February 2011
Received in revised form 18 July 2011
Accepted 27 August 2011
Available online 3 September 2011

Keywords:
Credit ratings
Feature selection
Cumulative probability distribution approach (CPDA)
Rough set theory (RST)
Rule filter

ABSTRACT

Although Asia is at the forefront of global economic growth, its investment environment is very risky and uncertain. Credit ratings are objective opinions about credit worthiness, investment risk, and default probabilities of issues or issuers. To classify credit ratings, analyze their determinants, and provide meaningful decision rules for interested parties, this work proposes an integrated procedure. First, this work adopts an integrated feature-selection approach to select key attributes, and then adopts an objective cumulative probability distribution approach (CPDA) to partition selected condition attributes by applying rough sets local-discretization cuts. This work then applies the rough sets LEM2 algorithm to generate a comprehensible set of decision rules. Finally, this work utilizes a rule filter to eliminate rules with poor support and thereby improve rule quality. The experimental focus was the Asian banking industry. Data were retrieved from a BankScope database that covers 1327 Asian banks. Experimental results demonstrate that the proposed procedure is an effective method of removing irrelevant attributes and achieving increased accuracy, providing a knowledge-based system for classification of rules for solving credit-rating problems encountered by banks, thereby benefiting interested parties.

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1. Introduction

While focused on emerging global economies, Asian banks are the most energetic and rapidly expanding banks worldwide. Following the Asian Economic Crisis that originated in Southeast Asian financial markets in 1997, Asian banks have aggressively clawed their way back to normalcy, frequently under strong government support [40]. Chang [60] indicated that governments in eastern Asia used local banks to support their real estate sectors and thereby pursue national economic development objectives. Clearly, banks play a critical role in economic recovery and promoting economic growth in Asia's rapidly growing capital markets. Banks are financial organizations whose primary activity is as a payment agent for customers and lending money. The intermediary role of banks is based on 'credit' and, thus, is closely linked to real life of us. When banks experience financial scandals or insolvency, panic typically ensues and, in the worst case, leads to systemic banking crises. For instance, the current global financial crisis was caused by reckless and unsustainable lending practices in the United States during 2007–2009 within the context of deregulation and securitization of real estate mortgages. The depressed financial situation resulting from the broad-based credit boom caused by a global speculative bubble in real estate and equities finally exposed other risky loans and over-inflated asset values, causing a global recession and significant macro-level effects, including extreme stock market devaluation, business bankruptcies, global financial disorder, a significant decline in international trade, and slumping commodity prices combined with rising unemployment and oil and food price inflation. Banks are clearly vital to financial market stability. Therefore, developing an indicator that represents the financial status and operational competence of Asian banks is urgently needed for parties interested in investing in Asia.

Credit ratings have recently attracted considerable attention from financial market investors looking for objective assessments of credit worthiness and investment risk, and the default probabilities of individuals, corporations, and even countries. A credit rating is a common index for evaluating the financial health of organizations and individuals. These ratings are assigned by credit-rating agencies, such as Fitch Ratings, Moody's, and Standard and Poor's (S&P), which are objective third parties that provide opinions on the relative ability of entities to meet their financial obligations. Fitch, which focuses on the banking industry, is a more specialized credit-rating agency than the other agencies, and has a large market share of Asia's banking industry. Credit ratings have existed for decades years in Europe and America, and have been implemented for Asian banks. Particularly, the characters of Asian banks for using credit ratings differ slightly, most follow Fitch Ratings. Thus, this study focuses on Fitch Ratings. The rules credit-rating agencies

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doi:10.1016/j.knosys.2011.08.021

apply in determining credit ratings are both complex and time-consuming; therefore, banks have difficulty manipulating the scale of credit ratings [9] and, consequently, credit ratings typically reflect real bank credit quality accurately.

In terms of general ratings problems, a dearth of 'public' knowledge exists on how credit agencies like Fitch make classification decisions [46]. This issue, credit-rating classification, has motivated a considerable amount of studies, many of which have obtained promising results for bonds [14,19], corporations [45], and insurers [12]; however, numerous application fields still need to be addressed. In Asia, much of which is characterized by prosperous economies with rapid economic growth rates and attractive investment potential, investors and other stakeholders see credit ratings as guidelines indicating the soundness of issuers and issues; however, few studies have examined credit ratings in the Asian banking industry, and the analysis of related measures and approaches is lacking [13]. Thus, this knowledge gap must be filled. Numerous quantitative and qualitative variables have been extracted from publicly available financial statements and/or enterprise information in the banking industry. These attributes degrade the performance, namely, increase the cost and time, of proposed models for solving the credit-ratings classification problem. Although these proposed models perform well, they do not explicitly identify the effects of credit ratings for the benefit of interested parties.

To overcome these shortcomings, this work constructs an intelligent hybrid model that solves the problem of classifying credit ratings based on Fitch Ratings of Asian banks. This work has the following three objectives: (1) apply a hybrid procedure to intelligently classify credit ratings in the Asian banking industry; (2) use an integrated feature-selection approach to identify actual determinants used by credit ratings agencies when determining credit ratings; and (3) provide meaningful rules and valuable information to Asian bank mangers, investors, and other stakeholders to achieve specific objectives.

2. Related works

This section reviews studies related to credit ratings, feature selection, the cumulative probability distribution approach (CPDA), and rough set theory (RST).

2.1. Credit ratings

Credit ratings are an index of creditworthiness. The credit-rating process distinguishes between 'good' and 'bad' credit, including all intermediate shades of gray [31]. Credit ratings are primarily used to assess credit worthiness, investment risk, and default probability of issuers and issues, including bonds, corporations, and banks. The main differences between long-term and short-term ratings are the period and rating range. The long-term ratings are divided into several categories, ranging from AAA to D, reflecting the highest and lowest credit ratings, respectively. Short-term ratings from AA to CCC can be modified by adding a plus or minus sign, indicating relative standing within major rating categories. A high initial rating indicates a low default probability and high credit worthiness, and *vice versa*. As mentioned, credit ratings are assigned by agencies, such as Fitch, that are typically considered objective third parties. Table 1 lists interpretations of long-term credit ratings by Fitch.

Credit-ratings agencies follow certain procedures and use domain knowledge to determine ratings scales using public and private financial data. Additionally, these agencies periodically update credit ratings based on changes in operating conditions and economic environments. Thus, credit ratings offer the following benefits [22]: (1) credit ratings can improve firm brand image; (2) credit ratings help investors evaluate and assess the credit risk of specific firms; (3) credit ratings increase financing flexibility for specific firms; and (4) credit ratings highlight key investment targets for investor decision-making and reduce the costs for interested parties associated with collecting information. Given the importance of credit ratings, particularly in investment markets, researchers have attempted to construct automatic classification systems that solve credit-rating problems using statistical and artificial intelligence (AI) techniques [6,18,21,56].

Shin and Han [45] developed a case-based reasoning approach using Korean bond-rating data and 12 variables to forecast firm bond ratings on five scales (i.e., A1, A2, A3, B, and C). Their system had better accuracy at 70.0% than multiple discriminant analysis (MDA) at 60%. Kumar and John [22], who applied an artificial neural network (ANN) with discriminant analysis (DA) using 14 variables, demonstrated that the ANN performed better than DA. Huang et al. [19] applied a support vector machine (SVM) and backpropagation neural network (BNN) as a benchmark and used 21 variables from the United States and Taiwanese financial markets. The Taiwan data contained 74 cases and the US data contained 265 cases. The SVM and BNN methods achieved an accuracy of approximately 80%. Chen and Shih [4], who also used an SVM method with 72 input variables to generate credit ratings for the Taiwanese banking industry, achieved an accuracy of 84.62% for four scales – twAA and above, twA, twBBB, and twBB and below (tw denotes Taiwan). Moreover, Pasiouras et al. [33] applied a novel multi-group hierarchical discrimination (MHDIS) method to Asian commercial banks using five scales based on Fitch Ratings. Their approach achieved an accuracy of 66.03%, exceeding that of DA at 53.73% and logistic regression (LR) at 47.55%. Florez-Lopez [12] compared MDA with multinomial logit (ML), ordered logit (OL), decision tree C4.5, Classification and Regression Trees (CART) Gini-univariate, and CART Gini-oblique using a sample of 257 European insurance companies. This analysis revealed that the CART Gini-oblique method performed best, with an accuracy of 74% for the five scales of AA, A, BBB, BB, and B. Table 2 summarizes these statistical methods and AI techniques.

2.2. Feature selection

Feature selection, also known as feature subset selection, is an important step in the data mining process, and has been a fertile research field since the 1970s in statistical pattern recognition

Table 1
The interpretations of long-term credit ratings by Fitch.

1. Investment Grade												
Interpretation	Highest quality	High quality			Strong payment capacity			Adequate payment capacity				
Scale	AAA	AA+	AA	AA−	A+	A	A−	BBB+	BBB	BBB−		
2. Speculative Grade												
Interpretation	Likely to fulfill obligations			High risk obligations			Current vulnerability to default			In bankruptcy or default		
Scale	BB+	BB	BB−	B+	B	B−	CCC+	CCC	CCC−	CC	C	D

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