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Credit risk measurement and early warning of SMEs: An empirical study of listed SMEs in China

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ABSTRACT

In the process of resolving financing difficulties of small and medium enterprises (SMEs) in China, the measurement of credit risk of SMEs is a very challenging problem. In this paper we develop a novel model based on the original KMV model with tunable parameters to measure the credit risk of Chinese listed SMEs. By setting two credit warning lines to monitor the credit crisis of listed SMEs, we find that the predictive accuracy of adjusted KMV model is stable to the change of default points in Chinese listed SMEs, which is different from KMV Company's existing result. Our study shows that the credit risk of listed SMEs in China is relatively high and tends to increase during the chosen period from the year 2004 to 2006. We also find that the asset size has significant impact on credit risk and there are few credit risk fluctuations before and after the split share structure reform.

1. Introduction

Credit risk is the risk of loss due to a debtor's non-payment of a loan or other line of credit (either the principal or interest (coupon) or both). Default occurs when a debtor has not fulfilled his or her legal obligations according to the debt contract, or has violated a loan covenant (condition) of the debt contract, which might occur with all debt obligations including bonds, mortgages, loans, and promissory notes. Since financial innovation and derivatives grow rapidly in competitive financial industry, credit risk measurement and management become essentially important.

Although small and medium enterprises (SMEs) are the most active economic units in the national economy, the operational risk and credit guarantee risk are very high in SMEs due to their particular characteristics, which lead to a low credit rating in general. The operating performance of Chinese SMEs is poor in general, which results in a high operational risk and guarantee risk to credit guarantee institutions [5,6]. The Financial System Survey Report of Chinese SMEs in 2003–2005 provided by People's Bank of China (including six major cities: Beijing, Xian, Dongguan, Taizhou, Wenzhou and Weihai), shows that 63.93% of the bank's gross bad loans are caused by SMEs. Due to the lack of effective collateral and guarantees, the banks lending to SMEs are confronting much larger default loss. According to the credit rating for 350,041 SMEs made by Industrial and Commercial Bank of China (ICBC China) in 2001, there are only 16.31% of SMEs in grade A or higher, but 83.69% of SMEs in grade BBB or lower by contrast. Credit rating is a main assessment tool referred by credit guarantee, which are very cautious to the SMEs with low credit rating. Therefore, funding shortage is one of the major problems for most SMEs which restrict their developments. Effective measurement of credit risk to SMEs has become a major challenge for financial institutions. With the rapid growth of SMEs Plate and the Growth Enterprise Market (GEM) coming up in China, the SMEs will have significant influence on Chinese economy as well as the capital market. However, the growth of most SMEs suffers great uncertainty and uncontinuity, in that they usually have established for a very short period and have very limited management experiences. Due to the "growth illusion", a kind of credit risk is hardly perceived in the case of high-growth SMEs excessively relying on debt financing [5]. Therefore, in this paper, we try to do some exploratory research on credit risk monitoring of Chinese listed SMEs.

The rest of the paper is organized as follows. A literature review about credit measurement and warning is provided in Section 2, followed by descriptions of the analytical models and methodologies in Section 3. Then, the parameter estimation, results comparison and analysis are discussed in Section 4. Section 5 concludes the paper.

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2. Literature review

Before 1970s, the financial institutions focused on semi-quantitative analysis in credit measurement and management, which were mainly subjective assessments of customer's credit by financial statement analysis. Since 1970s, the western developed countries represented by U.S. developed a series of credit risk models on measurement and management [3]. Thereby the combination of qualitative analysis and quantitative analysis in credit risk measurement in financial institutions is realized.

Currently, many models are available for credit risk measurement and credit rating [15,37]. In the main traditional credit risk measurement models, the banker's expert system and rating method are more subjective [29,30]. Furthermore, some statistical methods are commonly used for credit risk prediction. It includes logistic regression analysis [20,24,33], *K* nearest neighbor [13,28], multiple discriminate analysis (MDA) [16], *Z*-score model [1] and the improved ZETA credit risk model [26]. The general effort in credit rating prediction using statistical methods was that a simple model with a small list of financial variables was succinct and was easy to explain. However, the problem is that the multivariate normality assumptions for independent variables are frequently violated in financial data sets, which makes these methods theoretically invalid for finite samples [15]. Recently, Artificial Intelligence (AI) techniques, particularly the neural networks have been used to support credit rating and bankruptcy predictions [2,7,18,34,35]. However, models obtained in this machine learning method are usually very complicated and hard to explain, and they heavily rely on the samples and experimental data.

The modern credit risk measurement model includes four major approaches: CreditMetrics, Credit Portfolio View, CreditRisk+ and KMV model. The J.P. Morgan's CreditMetrics [8] and McKinsey's Credit Portfolio View [36] are directly related to the credit rating mechanism. However, because China's credit rating market is far from mature and lacks sufficient credit data, the above two models (CreditMetrics and Credit Portfolio View) cannot be used in China. It is also very difficult to apply the CreditRisk+ model [31] developed by the Credit Suisse Financial Products into Chinese credit market; that is because the key risk-driven parameter "default rate" of CreditRisk+ model is hard to estimate in present credit market of China. Moreover, the model requires the mutual debts to be independent [9]. The KMV model developed by the KMV Corporation is a structural model based on the modern corporate finance theory and the option theory. It would be very attractive to apply it to credit market of Chinese SMEs, where the financial data and credit information are insufficient, patchy or even doesn't exist at all. The KMV model can use appearance information for measurement, such as the fluctuation of stock prices, credibility, macro-economic conditions, and sector's credit risk. It is a dynamic forward-looking approach.

Previous studies confirm that the KMV model can be applied in the credit market. McQuown [22] pointed out that the financial report could reflect the history of the company and the market price could reflect the future development trend much better, yet the most accurate measurement of credit risk should use both information at the same time. Kurbat and Korablev [19] tested the KMV model by level validation and calibration analysis. They proved that the KMV model was very effective using the datum of 1000 U.S. companies in three years. Crosbie and Bohn [10] applied KMV model into financial companies and found that EDF value could accurately and sensitively monitor the credit changes before insolvency or when a credit event happened. The "New Basel Capital Accord" promoted Internal Ratings-Based (IRB) approach in credit risk management, where KMV was also recommended. It is clear that KMV model has been highly accepted and used in the world.

In recent years, Chinese scholars discussed the applicability of KMV model in China. Du et al. [11] focused on qualitative analysis of the model and pointed out problems in using KMV. Wang [32] provided comparative study of KMV and other credit risk models. He considered that the KMV model was more suitable for credit risk assessment of listed companies than other models. Recently, some scholars began to apply KMV model into credit risk identification in listed companies. Cheng and Wu [6] (sample number is 15), Zhang et al. [40] (sample number is 60), Yang and Zhang [38] (sample number is 144) and Ye et al. [39] (sample number is 22) adjusted the parameters of KMV model and found that the adjusted model could timely identify and forecast the credit risk of Chinese listed companies. Zheng [42] (sample number is 30) found that the EDF model did not send wrong messages to the listed companies with good performance, but the asset value and equity value in high-risk listed companies were overvalued. Ma [21] applied KMV model into the financial distress warning of Chinese listed companies, and found that KMV model had more obvious advantages than the Logistic and Fisher model. Although previous works provide theoretical and empirical proofs that the KMV model is a good guidance and reference for quantitative credit risk management in China, the inference cannot be made directly to Chinese market. Some existing works have discussed the relationship between asset size and default. Moody company's study shows that the asset size is an important factor affecting default. The default probability is very high in large companies who are well-funded, solid and capable of market risks resistance [14]. While in small-sized listed companies, the default probability is big due to the big volatility of stock price [41]. In this paper, we will discuss how the default probability is affected by various risk factors in Chinese listed SMEs. Traditional KMV model used to determine equity value volatility (σ_E) by simply adopting stock price volatility, but the effects of equity changes (e.g., the shares distribution) and changes in net assets per share are not considered. This paper will adjust some parameters in KMV model and develop improved version of KMV model to meet the needs of Chinese listed SMEs' credit market. As a unique phenomenon in China, the split share structure reform will also be discussed.

3. Models

3.1. KMV modeling description

KMV model developed by the KMV Company is based on the Merton Option Pricing Theory [23]. It is a set of conceptual frameworks to estimate the default probability of a company. The KMV model assumes that the company will default when the company's asset value is less than liabilities. Fig. 1 reveals the relationship between equity value and asset value. According to the basic idea of Merton model, the KMV model regards the company's equity value as the call option, which considers asset value as the underlying asset and the debt as the exercise price.

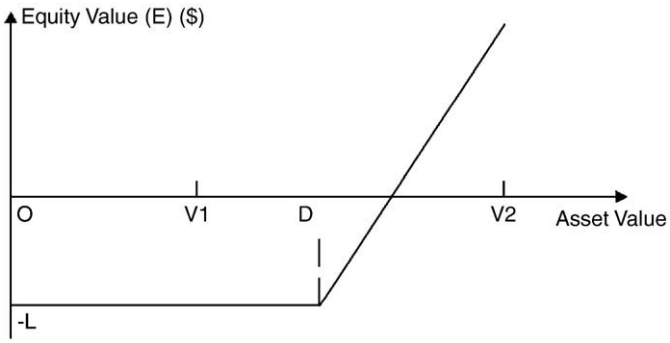

Fig. 1. The relationship between equity value and asset value.