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Research on Credit Risk Measurement Method of Credit Subject in Negative Profit Regime

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Abstract

This paper focuses on the industry sample rating data, taking the manufacturing industry sample as an example, because of the discontinuity of the current financial indicators in the optimization direction, that is, we can find two different ideal points in the positive and negative discrete regime. It is reflected in the under-utilization of prospects and risk information in the industry's credit evaluation analysis. Therefore, this paper further expands the prospect adjusted default distance credit evaluation model to the PADD model considering discrete regime, and establishes and verifies the rationality of the model.The conclusion of this article is that the PADD credit evaluation model considering the discrete regime has a good degree of discrimination between companies with different risks, which is reflected in the performance of each credit-level entity calculated by the model is not worse than the same ranking of DD method. Moreover, the consistency of the quarterly ratings and the mid- to long-term ratings based on the numerical results of the ratings in terms of stable forecasts also verifies the application value of the main model in this study.

Keywords

Credit Measurement; Negative Regime; Risk Aversion.

1. Introduction

The international voice of credit rating needs the support of rating methods and technology. According to Livingston (2018) (Livingston, Poon, & Zhou, 2018), at the present stage, China's rating scale is extensive, generally using four rating scales AAA, AA +, AA, AA -, while the international rating scale generally ranges from AAA to C, with more refined rating scales, such as grade 17 and grade 9(Izzi, Oricchio, & Vitale, 2011). That is to say, the current Chinese rating practice does not match the Basel II and III rules that rating scale should be fully refined and enterprises should be distributed as evenly as possible in all levels, which is not conducive to meeting the risk information needs of investors and borrowers; In addition, the rating services provided by rating agencies are generally based on the enterprise rating request, and the rating dates are mostly irregular. There is no regular batch rating and rating reporting mechanism, and the supply of enterprise credit risk information is not timely; Lack of accurate and timely credit risk monitoring is also not conducive to financial stability.

At present, the default distance method is a quantitative rating method widely used in the world. It is based on the "Black Scholes Merton" option pricing model, which was launched and put into use by KMV credit rating company in the 1980s. In 2002, KMV company was acquired by Moody's company, one of the three major rating agencies in the world, with us $240 million, forming Moody's KMV rating method(Löffler, 2005). The core of the method is to measure the credit risk of the credit subject by the distance to default (DD). The larger the default distance is, the lower the credit risk is. On the contrary, the greater the credit risk is. As a measure of credit risk, default distance is widely used in credit measurement practice because of its robustness(Jessen & Lando, 2015). However, this method is obviously not the end of digital

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credit rating. The default distance is determined by asset market value and its volatility, equity value and its volatility, and default point; Its limitation lies in that the financial fundamentals, momentum and consistency prediction data related to the prospect of credit subjects are not effectively applied to credit measurement analysis.

Therefore, Zhou Dandan (2019) put forward the credit rating method and system of prospect adjusted default distance Padd, that is, the method of credit rating by applying the three segment function relationship of prospect default distance with double reference points, which solves the problem that the current internationally popular credit rating method of default distance (DD) is only based on the real market dynamic data, But it can't apply the deficiency of the company's prospect and credit relationship information. However, for the credit subject with negative profit financial status, there are discontinuities or inconsistencies in its profit related indicators, such as market to current ratio, price to earnings ratio, its optimization direction, positive and negative ideal points, compared with the credit subject with positive profit financial status, as well as the risk characteristics of negative profit financial status, which make the credit subject with negative profit financial status have a higher risk, Its credit measurement needs corresponding technical solutions for processing.

Because the negative profit financial index with quarter as cycle exists in different credit entities in reality, even frequently, it has rating significance that can not be ignored. The invention aims to solve the problem of correcting the credit measurement of such credit subject under the negative profit financial state.

2. Literature Reference

KMV model assumes that based on the mapping relationship between historical default distance and default probability, the expected default frequency of bond subject can be calculated, that is, the default probability of debt company in a specific period in the future. The core measurement method of default distance is based on the option pricing theory proposed by black and choles (1973). The model holds that the credit of the borrower is a function of its asset value. The equity value of a company can be regarded as a European put option with the due debt x as the strike price and the market value of the company's assets V as the underlying. The calculated default distance index reflects the credit risk of the enterprise on the specified date. The smaller the default distance is, the greater the credit risk is. As a measure of credit risk, default distance has been widely used and discussed in credit rating practice and research because of its robustness and digital characteristics(Jessen & Lando, 2015).

There are basically three steps to determine the probability of default, the first step is to estimate the market value of the company's assets V_A and its volatility σ_V. Under the premise of known equity value and volatility, the solution method and procedure iteration method of the joint equation have been proved to be feasible by different researchers (such as Agarwal and Taffler (2008); Kisgen (2019)).

The second step is to the Distance-to-Default (DD), which is expressed by the standard deviation of the company's asset value away from the default point, that is $DD = \frac{V_A^t - DP}{V_A^t \sigma_V}$, and DP is the book value of liabilities.

The last step is to convert the default frequency (EDF) using the empirical default distribution. Assuming that the market value of assets follows lognormal distribution, according to the option pricing theory, the market value of assets follows the following stochastic process at time t, $lnV_t = lnV + \left(\mu - \frac{\sigma_V^2}{2}\right)t + \sigma_V\sqrt{t}\varepsilon$, where μ is the expected return of the market value of the company's assets, which is replaced by the asset growth rate in this paper, ε is a random

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sampling value from the normal distribution, and dz id a Wiener process. The expected probability of default can be expressed by

$$EDF = \Pr(V_t \le DP) \Pr\left[-\frac{ln\frac{V_A}{DP} + \left(\mu - \frac{\sigma_V^2}{2}\right)t}{\sigma_V\sqrt{t}} \ge \varepsilon \right] = N(-DD) . \quad (1)$$

To sum up, the main advantages of the default distance evaluation method are: Based on the BSM model, the construction of the model mainly comes from the real-time stock price information and the information in the accounting statements, without strict restrictions on the time and sampling range, so it is widely used in the practice of credit rating industry.

Merton model is based on strict experimental assumptions. If the subject company has a simple capital structure, the asset value presents a lognormal distribution. Once the deviation of realistic conditions occurs, it may lead to errors in the empirical test results of the model. This is also one of the limitations of the default distance model in practical application.

The existing scholars try to construct the mixed model of KMV model and accounting model, but there are not many literatures on the systematic comparison and interpretation of the two models, and the conclusions are also different. Shumway (2001) pointed out that adding accounting ratio to default risk model can improve the accuracy of model prediction. Hernandez Tinoco and Wilson (2013) pointed out that Altman Z-score evaluation method and DD evaluation method have the characteristics of quantitative analysis, and play a complementary role in default prediction. The moderate correlation between the two shows that neither of them is enough to explain credit risk alone, which also means that the combination of accounting variables and market variables is useful (Trujillo-Ponce, Samaniego-Medina, & Cardone-Riportella, 2014). Doumpos, Niklis, Zopounidis, and Andriosopoulos (2015) studied the combination of default distance and financial data, and explored the development of credit rating analysis method based on index integration by applying multi-attribute decision analysis method; Blöchlinger and Leippold (2018) proposed the augmented prediction model by combining the default distance method with Altman-z value credit scoring method based on financial indicators; PEREIRA and RUA (2018) studied the relationship between the change of bank default distance and the asset pricing and prospect value of real enterprises, and proposed that the calculation of prospect value of real economy enterprises should include the bank factor related to bank default distance; Nagel and Purnanandam (2020) reported the sensitivity of bank credit risk to the negative impact of the real economy, and proposed the application of discrete probability of default model to calculate bank credit risk. (Li & Faff, 2019) adopted the rank transformation method of DD and Z-score mixed model, proving that when measuring the credit risk of large and highly liquid companies, or in the case of market collapse, they rely more on the weight of market information; However, in the case of high degree of information asymmetry, the model is more dependent on the weight of accounting information(Li & Faff, 2019).

3. The Model

In this paper, KMV model is introduced to calculate the default distance of enterprises. On this basis, a comprehensive evaluation model of prospect credit risk considering discrete qualitative state is established. KMV model uses the distance between the expected value of enterprise assets and default point to measure the size of default risk. As a dynamic credit risk evaluation model, KMV model can be updated in real time according to the changes of market information of listed companies, which has a certain forward-looking and stability.

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The basic assumption of KMV model is that if the value of the company's assets is less than that of its liabilities, the company will lose its solvency. When buying corporate bonds, we assume that the equity price can be regarded as the European call option of the company's equity, and the strike price is d. therefore, the equity value is related to the maturity of corporate bonds, liabilities, risk-free interest rate, and the There is a certain relationship between the volatility of the company's asset value and the company's asset value, which can be expressed by formula

$$V_E = h(V_A, \sigma_A, r, D, T) \tag{2}$$

Among them, V_A is the value of the company's assets, σ_A is the volatility of the company's asset value, R is the risk-free interest rate, D is the liability, t is the maturity of the company's bonds, and V is the risk-free interest rate E is the equity value of the company.

Assume that, V_A is in accordance with geometric Brownian motion. In Black Scholes' option pricing model, asset value and its volatility can be obtained by solving simultaneous equations

$$\begin{cases} V_E = V_A N(d_1) - De^{-rT} N(d_2) \\ \sigma_E = \dfrac{V_A \sigma_A}{V_E} N(d_1) \end{cases} \tag{3}$$

Among the above, $N(d_1), N(d_2)$ is standard normal distribution, and $d_1 = \frac{\ln(V_A/D)+(r+\sigma_A^2/2)T}{\sigma_A\sqrt{T}}$, $d_2 = d_1 - \sigma_A\sqrt{T}$.

In the future value calculation index, CFP is introduced to replace the current market rate, $CFP = \frac{CF}{P} = \frac{1}{PCF}$, where CF is cash flow per share (operating), P is the price per share, and the value of CFP is the greater and better, regardless of positive and negative.

The qualitative samples include all the companies with positive P/E ratio in the current quarter, that is, the qualitative samples include all the companies with negative P/E ratio in the current quarter, that is, let the overall sample in the current quarter be (PE ≠ 0), $\Theta = \{PE^+ | PE > 0; PE^- | PE < 0\}$.

Entropy weight method is used to calculate the weight of the samples quarterly, $w_j = \frac{1-e_j}{m - \sum_{j=1}^{m} e_j}$, where $e_j = -\frac{1}{\ln n}\sum_{i=1}^{n} p_{ij} \ln p_{ij}$ represents the entropy value of the j-th index, and v_{ij} is the normalized value of the original index value;

using $v_{ij} = (x_{ij} - \min_j x_{ij}) / (\max_j x_{ij} - \min_j x_{ij})$, and i = 1,2,..., n is the credit subject; j=1,2,..., m is the index.

The weight of PE + is the median of multi period weight, the same as PE- regime.

The results show that without considering the outliers, the weight distribution of each index has a certain rule. For example, the P/E ratio index has a larger weight in the calculation of PE+ sample's prospect value, while it has a smaller weight in the calculation of PE Sample's prospect value. This result is not only reasonable, but also shows the necessity of qualitative division of P/E ratio.

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4. Experiments and Results

In this paper, 499 samples of A-share listed manufacturing enterprises are selected, and seven indicators including net profit growth rate, consensus forecast earnings per share, return on equity, P/E ratio, current market rate and three-month momentum are selected as the calculation method of prospect evaluation value.

In this paper, under the classification of China Securities Regulatory Commission, manufacturing enterprises are taken as the object of rating to construct samples. This treatment also takes into account the differences in stock volatility, short-term debt level and long-term debt level of different industries, and the default distance calculated by KMV model is not comparable. In addition, we obtain the financial indicators and market indicators of listed companies from the wind database. Among them, the financial index data is used to build the prospect evaluation model, and the market index data is used to calculate the default distance risk value of each enterprise.

The distribution of prospect value and default distance from the first quarter to the second quarter of 2014 is shown in Figure 1.

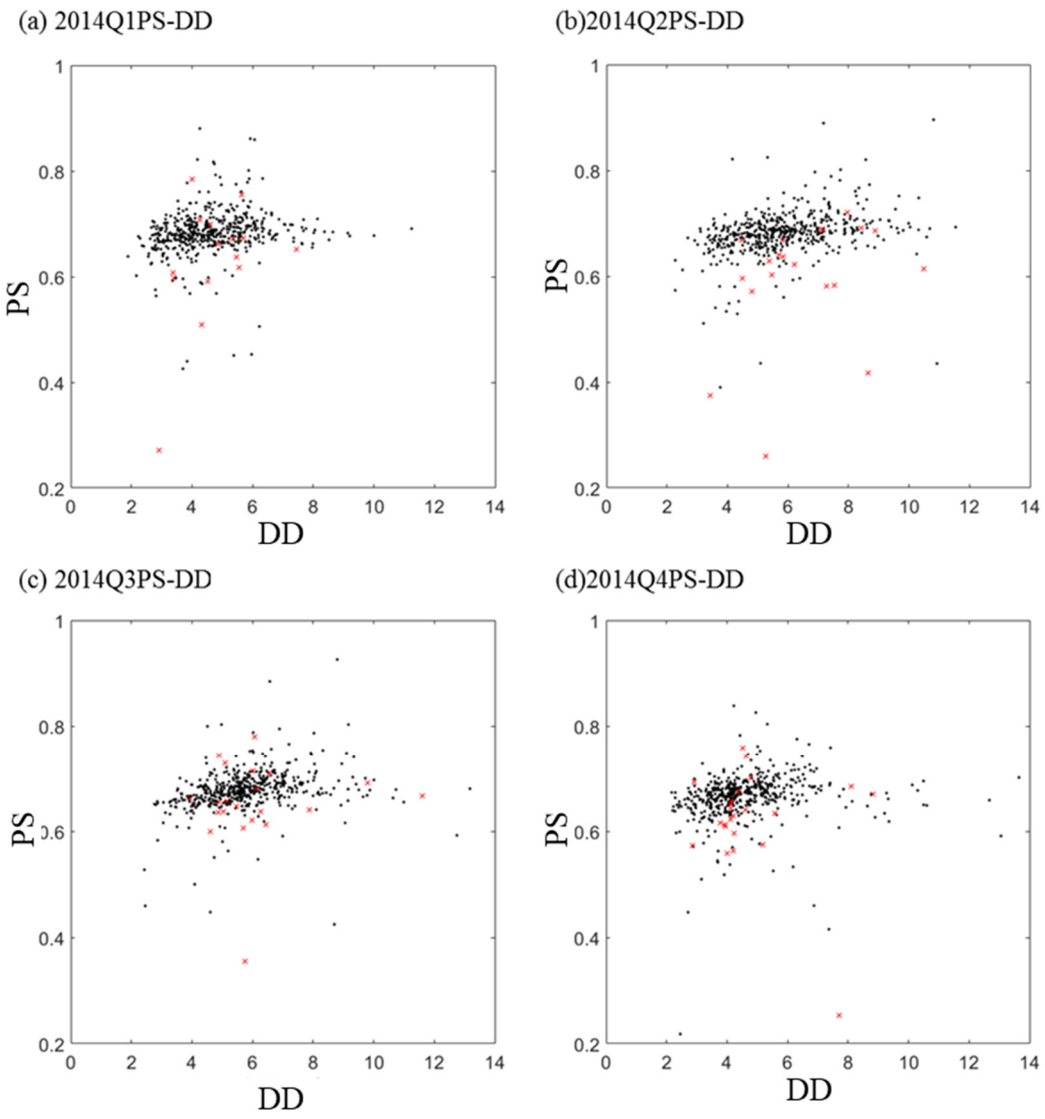

Figure 1. The distribution of PS and DD

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As shown in figures 1, the dot represents the prospect value and default distance of PE + qualitative samples, and the fork represents the prospect value and default distance of PE qualitative samples. We can clearly find that even in some quarters, the default distance of PE qualitative credit subjects far exceeds the average level of PE + qualitative samples.

The default risk and prospect evaluation values of PE qualitative samples do not show significant differences with PE+ qualitative samples. According to our hypothesis, the default distance and prospect value of samples with negative PE should be adjusted below the risk aversion reference point acceptable to investors in theory, so that we can get more reasonable and correct risk assessment in the credit rating of the industry.

Secondly, we give meaning to the two reference points (P1 and P2) on which the benchmark model is built. The former is defined as the reference point of risk aversion, and the latter is defined as the reference point of prospect inhibition. For the first reference point, we think that the prospect evaluation value and default distance measurement value of the samples that meet the definition of discrete negative qualitative state should be adjusted to the risk aversion range of the corresponding quarter. Through empirical test, we find that the adjusted credit risk level can better reflect the high-risk characteristics of these samples in practice.

5. Conclusion

Based on the existing financial index evaluation system, there are discontinuous optimization directions for the price earnings ratio and other related indexes highly related to the credit risk rating of enterprises under different discrete quality states, and the positive and negative ideal points (the best and worst points under the index) are inconsistent, which limits the accurate measurement of credit risk, This paper puts forward the problems that should be considered when measuring the risk of credit subject in negative profit state.

And then, through the discrete qualitative division of the credit subject, this paper adjusts the risk aversion section based on the lower prospect valuation and higher credit risk level of the discrete negative qualitative sample subjects.

However, in the current experiment, we choose the factor set which has significant predictive ability to the proxy variable y of investment prospect as the effective factor $\mathbf{x}$, namely, $Y_{t+1} \leftarrow x_t$, denotes x_t to Y_{t+1} has significant predictive ability, and the statistical test method and correlation regression method may be used in the future research.

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