An analysis of credit risk of middle and small-sized enterprises in the inclusive financial system: an example from China

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Abstract. Inclusive finance is a development direction of current finance reform for the nations of the world. Based on the theory of inclusive finance, this paper analyses the credit risk of middle and small-sized enterprises in China through KMV model. In empirical analysis, we choose the sample data coming from ST company, *ST company and non-ST company in the growth enterprise market of China. After calculating the default risk and the default probability of enterprises, the results show that, in general, the enterprises in unnormal operation have higher default risks relative to the enterprise in normal operation. According to sample data, individual enterprises in unnormal operation also have lower default risks. In the inclusive financial system, governments should pay more attentions to the development of middle and small-sized enterprises, and establish some proper measures to provide financial services for middle and small-sized enterprises, especially for enterprises in unnormal operation.

1. Introduction

With the development of society and economy, all classes of society produce the huge demands for financial services. But the unbalanced economic development leads to that some people cannot access to financial service to some degree [1]. The big financial institutions usually pay more attentions to some developed regions of economy and high-income groups, and neglect vulnerable groups, vulnerable areas and disadvantaged enterprises [2]. The mismatching of financial service has seriously influenced on national economic sustainable development. Although many financing ways can be adopted in theory, the middle and small-sized enterprises still face the problem of financing difficulties, such as narrow financing channels and limited financing scales [3]. Therefore, it is necessary to construct the inclusive financial system for any country, whether developed or developing. Even in a developed country, inclusive financial system may still need to be improved further.

At present, the main measuring method of credit risk focuses on Credit Metrics model, Credit Risk+ model and KMV model. Credit Metrics model was put forward in 1997 by JP Morgan. This model holds that the change of credit grade can cause credit risk, except for default behavior [4]. In Credit Metrics model, many indicators are included into an integrated framework of the analysis, such as credit rating, default rate, recovery rate and default correlation. Then Credit Risk+ model was first proposed by Credit Suisse Financial Products (CSFP) in 1997. As a statistical model of default risk, it considers only two states: default state and nondefault state. Based on a random default rate, Credit
Risk+ model measures the changes of expected loss and unexpected loss [5]. But Credit Metrics model mainly focuses on the changes of expected value and unexpected value. At last, KMV model was presented by KMV company in 1997. This model predicts loss given default (LGD) by using an expected delinquency frequency (EDF). To be specific, KMV model calculates EDF through the stock price of corporate borrower first, and then calculates LGD through EDF [6]. Because Credit Metrics model and Credit Risk+ model need a giant database, including rating data and macro-economic data, KMV model is more suitable for the research of this paper.

The main contributions of this paper are as follows: (1) we use the KMV model analyze the credit risk of middle and small-sized enterprises after the implementation of inclusive finance in China; (2) in the basis of Chinese stock market, we choose ST company, *ST company and non-ST company as research samples to comparing the credit risk of companies under different business performances; (3) empirical result shows that the enterprises in unnormal operation have higher default risks relative to the enterprise in normal operation in the inclusive financial system; (4) the emphasis of risk prevention is the default risk of middle and small-sized enterprises in unnormal operation for governments. The rest contents are organized as follows. Section 2 expounds inclusive financial system from the two aspects of inclusive finance and theoretical basis. Then, KMV model is adopted to analyze the credit risk of middle and small-sized enterprises in the inclusive financial system by using sample data coming from the growth enterprise market of China in section 3. Finally, the conclusions are drawn in section 4.

2. Inclusive financial system

2.1. Inclusive finance

Inclusive finance emphasizes a complete range of financial services for people coming from the entire class in society [7]. Especially for people in poverty area, inclusive finance offers them an opportunity to enjoy financial service. To be specific, inclusive finance includes three aspects. First, inclusive finance is a social idea. Every person should have the right to enjoy financial service in a society. The proposed inclusive finance displays society fair and harmony. Then, inclusive finance needs innovation. This innovation mainly reflects in financial products, financial institutions and financial systems. Finally, inclusive finance must keep the same treatment for different strata. The objects of financial serves should shift to low income people, not just high-income people.

The characteristics of inclusive finance can be concluded the following four parts: (1) Both households and firms can equally and fairly enjoy a series of financial services; (2) Inclusive finance has a sound service system, including the financial institution system, the financial management system and the financial regulatory system; (3) Financial institution has the ability of sustainable development, and can provide financial services for a long time; (4) Financial institutions offer a variety of financial products for clients [8]. In addition, the framework of inclusive financial system contains four layers: customer level, micro level, middle level and macro level. In customer level, low-income stratum is in the center of inclusive financial system. The micro level mainly relates to the provider which offers retail financial services. Then the middle level emphasizes financial infrastructure construction, which realizes the decrease of transaction costs in financial business. At last, macro level mainly concerns macro-financial supervision coming from central bank.

2.2. Theoretical basis

2.2.1. Financial exclusion theory

Financial exclusion was firstly seen in America, but much valued in Britain. The Great Depression and Economic Crisis drove the banking industry to focus on the goal of value maximization in the 1990s. Financial institutions began segmenting the market and tried to find a safer market, which was consisted of groups having powers and influences. However, for some poor and disadvantaged groups, financial institutions generally closed their branch offices. Finally, these poor and disadvantaged groups became increasingly difficult to obtain financial services [9].
In general, the objects of financial exclusion are mainly summarized as vulnerable groups, vulnerable areas and disadvantaged enterprises [10]. At first, vulnerable groups refer to low income people and poor people, who are hard to obtain financial services and products owing to the limitation of economic capacity, social status and education level. Then, vulnerable areas are widespread for every country. The geographical disadvantage is also an important restricting factor of sustainable development in inclusive finance. At last, disadvantaged enterprises mainly means middle and small-sized enterprises in bad operating states. These enterprises are always lack of financing channels, and many traditional financial institutions aren’t inclined to give a credit support.

Overall, financial exclusion theory is an emerging theory, which expounds the difficulties of financial services for vulnerable groups in society [11]. These difficulties concentrate in savings exclusion, loan exclusion, bank exclusion and insurance exclusion.

2.2.2. Credit risk theory

Credit risk means that the debtor cannot perform debt service obligations according to the previous agreement owing to all sorts of unpredictable reasons, thus the creditor confronts the possibility of losses [12]. The reasons of default may come from economic cycle and company performance. The default rate of enterprise always decreases in economic expansion. Whereas, an enterprise is inclined to default during economic downturn. In addition, a bad company performance probably can’t afford to debt service, and the probability of credit risk increases [13].

Credit risk has four types: default risk, market risk, income risk and purchasing power risk. More precisely, default risk manifests that the debtor is unable to service the debt on time because of some reasons, such as cash flow dilemma, bad management and lagging sale. Market risk indicates that the market price fluctuation may cause the downside risk of security price. With the longer time period, security price is more sensitive to the fluctuation of interest rate, and market risk increases further. When long-term funds are used for short-term investments, real investment income is probably higher than expected investment income with the appearance of income risk. Considering the influence of inflation, the real purchasing power of investment income is lower than the expected purchasing power, when the real inflation is higher than the expected inflation.

Besides, credit risk has some unique characteristics, such as potentiality, chronicity, destructiveness and uncontrollability. For the bond issuers, credit risk can increase the financing costs of enterprises. And for the bond investors, credit risk downgrades the credit rating of bond, and reduces the value of the bond. The measuring method of credit risk usually centres on KMV model, which adopts stock data to calculate the probability of default based on Black-Scholes option pricing formula [14].

3. Empirical analysis

KMV model is often used as a measuring method of credit risk, which shows the default interval in essence [15]. If an enterprise has higher liabilities rather than assets on the expiry date, this enterprise will probably default on its debts. In KMV model, Distance-to-Default is usually used for measuring the default risk of enterprise, abbreviated as DD. In general, a higher DD indicates a lower probability of default. The liability of enterprise is often classified two parts: the current liability of enterprise (STD) and the long-term liability of enterprise (LTD). According to KMV model, DPT, DD and Pi, can be shows by expression (1), (2) and (3), respectively [16]. The above parameters are described in table 1.

\[
DPT = STD + \frac{1}{2} LTD
\]  
\[
DD = \frac{\ln \left( \frac{V_d}{D} \right) + (\mu - \frac{1}{2} \sigma^2)T}{\sigma \sqrt{T}} = \frac{E(V_d) - DPT}{E(V_d) \sigma_d}
\]
\[ P_i = N \left[ -\frac{\ln \frac{V_A}{D} + \left( \mu - \frac{1}{2} \sigma_A^2 \right) T}{\sigma_A \sqrt{T}} \right] = N(-DD) \]  

(3)

Table 1. The description of parameters

| Parameters | Descriptions | Parameters | Descriptions |
|------------|--------------|------------|--------------|
| \( V_A \)  | The asset value of enterprise | \( \mu \)  | The mean value of asset value |
| \( D \)    | The market value of enterprise debt | \( \sigma_A \) | The volatility of asset value |
| \( T \)    | The maturity date of enterprise debt | \( E(V_A) \) | The expectation value of \( V_A \) |
| \( r \)    | The riskless interest rate | \( P_i \)  | The default probability |
| \( N(\cdot) \) | The standard normal distribution | STD | The current liability of enterprise |
| DPT        | The default point | LTD | The long-term liability of enterprise |

As the research on credit risk is from the perspective of small and medium-sized enterprises, all sample data come from the growth enterprise market of China. This paper chooses ST company, *ST company and non-ST company having the same scale assets comparing with ST company and *ST company. In the process of data selection, this paper chooses more industry as much as possible. But, because of the limitation on sample data, many companies belong to manufacturing industry in the final result of data selection.

The sample interval in the paper is from Jan. 30, 2017 to Dec. 29, 2017. All sample data come from Wind database. The riskless interest rate is supposed as one-year deposit rate at 1.50%, which is published by the People's Bank of China in 2017. And the maturity date of enterprise debt is assumed to be equal to one year. Table 2 and 3 show the DPT of enterprise in normal operation and unnormal operation, respectively. And we can also calculate the asset value of enterprise, the volatility of asset value, the distance-to-default and the default probability. The results are shown in tables 4 and 5.

Table 2. The DPT of enterprise in unnormal operation

| Stock code | Industry                 | STD (Million RMB) | LTD (Million RMB) | DPT (Million RMB) |
|------------|--------------------------|-------------------|-------------------|-------------------|
| 002070     | Manufacturing            | 1998.61           | 85.65             | 2041.44           |
| 002134     | Manufacturing            | 199.95            | 16.06             | 207.98            |
| 002188     | Leasing and business     | 258.86            | 0.31              | 259.02            |
| 002207     | Mining                   | 381.55            | 0.00              | 381.55            |
| 002248     | Manufacturing and catering | 1135.87         | 67.50             | 1169.62           |
| 002306     | Accommodation            | 88.49             | 19.23             | 98.11             |
| 002312     | Manufacturing            | 135.55            | 245.58            | 258.34            |
| 002427     | Manufacturing            | 4540.18           | 756.22            | 4918.29           |
| 002473     | Manufacturing            | 81.90             | 0.36              | 82.08             |
| 002490     | Manufacturing            | 3619.39           | 253.96            | 3764.37           |
| 002504     | Building                 | 5099.36           | 0.00              | 5099.36           |
| 002571     | Manufacturing            | 352.01            | 2.18              | 353.10            |
| 002604     | Manufacturing            | 584.14            | 805.16            | 986.72            |
### Table 3. The DPT of enterprise in normal operation

| Stock code | Industry               | STD (Million RMB) | LTD (Million RMB) | DPT (Million RMB) |
|------------|------------------------|-------------------|-------------------|------------------|
| 002058     | Manufacturing          | 27.35             | 3.22              | 1.31             |
| 002883     | Technology service     | 51.73             | 0.04              | 7.13             |
| 002878     | Leasing and business   | 135.06            | 3.20              | 6.76             |
| 002881     | Manufacturing          | 307.02            | 4.33              | 4.65             |
| 002753     | Manufacturing          | 267.40            | 275.47            | 5.52             |
| 002724     | Manufacturing          | 155.05            | 17.06             | 2.94             |
| 002690     | Manufacturing          | 240.47            | 65.87             | 3.25             |
| 002364     | Manufacturing          | 211.44            | 8.88              | 4.16             |
| 002263     | Manufacturing          | 1058.95           | 137.86            | 1.15             |
| 002181     | Leasing and business   | 755.09            | 73.28             | 3.38             |
| 002145     | Manufacturing          | 2316.96           | 539.31            | 1.88             |
| 002366     | Manufacturing          | 2682.76           | 979.05            | 3.21             |
| 002496     | Manufacturing          | 3237.53           | 858.29            | 2.52             |

### Table 4. The default risk of enterprise in unnormal operation

| Stock code | \( V_A \) | \( \sigma_A \) | DD      | \( P_i \)   |
|------------|-----------|--------------|---------|-------------|
| 002070     | 3313.905  | 0.308        | 3.222   | 0.00064     |
| 002134     | 982.958   | 0.449        | 2.111   | 0.01740     |
| 002188     | 1243.335  | 0.466        | 1.909   | 0.02815     |
| 002207     | 1472.139  | 0.468        | 1.687   | 0.04578     |
| 002248     | 3418.479  | 0.530        | 1.664   | 0.04809     |
| 002306     | 5860.482  | 0.489        | 1.989   | 0.02337     |
| 002312     | 7664.821  | 0.247        | 3.911   | 0.00005     |
| 002427     | 8357.787  | 0.312        | 3.119   | 0.00091     |
| 002473     | 7529.111  | 0.155        | 5.495   | 0.00000     |
| 002490     | 7647.509  | 0.228        | 3.926   | 0.00004     |
| 002504     | 10535.375 | 0.191        | 3.958   | 0.00004     |
| 002571     | 23168.675 | 0.652        | 1.323   | 0.09293     |
| 002604     | 10548.164 | 0.157        | 4.160   | 0.00002     |
Table 5. The default risk of enterprise in normal operation

| Stock code | $V_A$   | $\sigma_A$ | DD    | $P_i$  |
|------------|---------|------------|-------|--------|
| 002058     | 8046.529| 0.304      | 2.454 | 0.00706|
| 002883     | 3232.706| 0.281      | 3.335 | 0.00043|
| 002878     | 5003.432| 0.268      | 3.541 | 0.00020|
| 002881     | 2886.415| 0.375      | 2.316 | 0.01028|
| 002753     | 3623.754| 0.263      | 2.577 | 0.00498|
| 002724     | 3975.253| 0.361      | 2.698 | 0.00348|
| 002690     | 8609.090| 0.258      | 3.764 | 0.00008|
| 002364     | 15601.855| 0.169     | 4.050 | 0.00003|
| 002263     | 3045.403| 0.292      | 3.330 | 0.00043|
| 002181     | 7682.777| 0.190      | 2.693 | 0.00355|
| 002145     | 8844.430| 0.110      | 3.855 | 0.00006|
| 002366     | 2888.463| 0.224      | 3.927 | 0.00004|
| 002496     | 6270.347| 0.234      | 3.600 | 0.00016|

In order to reflect the comparison of DD in different types of enterprises, the mean and variance of DD are calculated in table 6. The mean of DD is higher for enterprise in normal operation, and the variance of DD is lower for enterprise in normal operation. Table 6 indicates that the enterprise in normal operation has the lower default risk and the relative stable value of DD. As for the enterprises in unnormal operation, the higher variance shows that the value of DD has a wide range of fluctuation based on the mean 2.960. The maximum and minimum also reflect this difference about the value of DD. In addition, according to tables 4, 5 and 6, the individual enterprises in unnormal operation have higher values of DD, which even exceed the maximum of DD comparing with the enterprises in normal operation. For example, the DD values of stock code 002473 and 002604 in table 4 are 5.495 and 4.160, respectively, which are also greater than the maximum of DD in table 5. So, in general, the enterprises in unnormal operation have higher credit risks, relative to the enterprises in normal operation. However, there are individual enterprises in unnormal operation having the lower credit risks. For commercial banks, they prefer to offer loans to the enterprise in normal operation.

Table 6. The comparison of DD in different types of enterprises

| The types of enterprises | Mean | Variance | Maximum | Minimum |
|--------------------------|------|----------|---------|---------|
| The enterprises in normal operation | 3.242 | 0.614 | 4.050 | 2.316 |
| The enterprises in unnormal operation | 2.960 | 1.276 | 5.495 | 1.323 |

4. Conclusions

This paper chooses financial data of 26 listed enterprises, which contains 13 enterprise in normal operation and 13 enterprise in unnormal operation. KMV model is used for analyzing the credit risks of enterprises, and the values of DD and the default probabilities are calculated by means of the following parameters: $V_A$, $V_E$, $\sigma_A$, $\sigma_E$ and DPT. Owing to the higher default risk of middle and small-sized enterprises, the government should increase the supports to middle and small-sized enterprises,
especially for the enterprises in unnormal operation, give full play to the development potentials of middle and small-sized enterprises in the inclusive financial system.

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