Evaluation and Influencing Factors of Default Risk and Interest Rate Risk for Bonds

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Abstract. This article studies the default risk and interest rate risk of bonds in terms of evaluation methods and influencing factors based on 15 literature articles. The paper showed that the main evaluation models for the default risk include the KMV model, Logistic model and ZETA model, while those for interest rate are comprised of VaR model, GARCH Model, CIR model and VASICEK model. Moreover, the influencing factors of both the the default risk and interest rate risk were also investigated in this paper. It is found that profitability, debt paying ability and operating capacity of the enterprises are the main influencing factors for the bond default risk, whereas the three factors consisting of market competition structure, transaction scale and macroeconomic variable affects the interest rate risk the most. This paper might provide some useful aids for the researchers who are interested in the bond risks.

Keywords: Bonds · Default risk · Interest rate risk · influencing factor · Evaluation models

1 Introduction

With the development of economy, the assessment of bond risk becomes more and more important, among the bonds issued by enterprises, there are many kinds of risks in bonds. Among them, default risk and interest rate risk are the two most significant risks in corporate bonds: credit risk and interest rate risk. Default risk refers to the influence caused to the other party by the trader's failure to fulfill his promise in the process of credit transaction [1].Anderson defines credit risk as "the possibility that a legally enforceable contract may become worthless (or at least substantially less valuable) due to counterparty default and bankruptcy." Saunders and Cornett say that default risk is "the risk that the committed cash flows of loans and securities held by financial institutions may not be paid in full." Therefore, credit risks arise due to defaults of debt issuers and derivative counterparties (Hull) [2]. In addition, according to statistics, from 2010 to the past 50 years, the number of bond defaults has gradually increased.

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In the past ten years, interest rate risk has been an important factor affecting investment risk management. Tai used GARCH model to estimate the investment risk of bank bonds, and the results showed the impact of interest rate changes on bonds [3].

In addition, Beirne, Caporale and Spagnolo have studied the sensitivity of banks in 16 countries to interest rate changes, further confirming the impact of interest rate risk on bonds [3].

2 Evaluation of Default Rate Risk

2.1 KMV Model

There are many kinds of bond default risk assessment, among which KMV model is one of the most mainstream methods to study bonds. After the financial crisis, China's three banks have become the three banks with the highest attention in the world. In order to identify the credit risks of the three banks, based on the KMV model, this paper focuses on the default risks of Bank of China (BOC), Industrial and Commercial Bank of China (ICBC) and China Construction Bank (CCB) [4]. KMV model named after three founders of KMV Company, DF3X is based on Black-Scholes (B-C) and Merton model, using option theorem to measure default risk [5]. The KMV model is generally divided into four steps to calculate the default rate of a company: (1) The price of the company's stock and the par value of the bond. (2) Determine the default point (DPT). Confirmed by KMV model, it is found that the value of companies with high default risk is generally greater than current liabilities plus 50%long-term liabilities. (3) Estimate default DD (default-distance). Default risk refers to the extent to which the asset value of an enterprise declines more than the enterprise can bear within a certain period, which can not only be used to measure the default risk of corporate bonds, but also be used for comparison between companies. The last step is to estimate the default probability of corporate bonds. Based on the mapping between default distance and expected default rate, corporate credit level can be reflected to some extent, so as to estimate the default probability of corporate bonds [4]. By using KMV model to calculate the default risk, we come to the conclusion that China Construction Bank is the bank with the highest default risk among the three banks. The reason is that the non-performing loan ratio decreased slightly, the ratio of deposits and loans decreased, the ratio of non-interest income to operating income decreased, and the core capital adequacy ratio decreased. But the data show that the risk of default at all three banks is rising. In addition, the default risk of Chinese commercial banks is compared with Moody's rating. We also use THE KMV model to calculate the EDF value of banks and the credit rating given by Moody's rating agency, and find that the EDF value of Chinese commercial banks is generally lower than the credit value given by Moody's rating agency. This indicates that Chinese commercial banks have a high risk of default [6]. Arora et al. studied several models that are longest used to calculate bond default risk, and found that KMV model is the most effective model to evaluate default risk. Meanwhile, Korablev&Dwyercollected the data of dozens of different countries and regions from 2006 to 2016, and found that compared with Z score model and Logit model, KMV model had higher accuracy [7].

2.2 Logistic Model

When calculating the default risk of corporate bonds, the Logistic model is used for research. When logistic model was used, logistic regression analysis was performed in reality. In order to study the relationship between binary and Ordinal Numbers, the method corresponded with the linear data of logistic model, and each company in this experiment was given a Z value in the form of failure probability. Linearity is used to analyze linear combinations of independent variables, while Logit is used to analyze probability functions used in the event of default. In Logit regression, its research purpose is to evaluate the effect of balance sheet variables and non-financial variables on corporate bond default. Through the Logit model, the research on the default risk of corporate bonds draws a conclusion that young companies have greater default risk than older companies. The reason may be that older companies have established a good reputation in the credit industry, which relatively alleviates the problem of asymmetric information of companies. Therefore, older companies can take advantage of this advantage to obtain more credit lines and repayment terms, and better reduce the default risk of the company.

2.3 ZETA Model

Z model is one of the most famous rating methods, which was proposed by Edward I. Altman, the most famous Economist in The United States. In 1977, Altman, Haldema and Narayanan successfully launched the ZETA model after improving the Z model. The biggest difference between ZETA model and Z model is that the original five variables are changed into seven variables. Compared with Z model, ZETA model has significantly improved its accuracy and can more accurately predict the default risk of the company. Z model and ZETA model can accurately reflect the credit situation of borrowers in mainland China in a certain period, which is more helpful for companies to predict bond defaults. According to the calculation of ZETA model, when ZETA is positive, it proves that the company has the ability to pay debts, and most of the debts of the company are more than one year; on the contrary, when ZETA is negative, it proves that the acquisition of the company is more than one year, then the default risk of the company will be relatively high [1]. However, ZETA model still has certain risk-1. One of the financial indicators of ZETA model is the standard. Generally speaking, it takes a certain amount of time for a company's financial problems to be exposed, so ZETA model's rating of a company in a short period of time is not very accurate. ZETA model assumes that all independent variables and dependent variables are in a linear relationship, but this is not the case, so there will be some errors in the accuracy of this model [8]. So ZETA's model can only be used to predict fixed differences between traders.

3 Evaluation of the Interest Rate Risk

3.1 VaR Model and GARCH Model

In recent years, with the acceleration of interest rate liberalization, financial market transactions have become more active, the asset and liability structure of commercial

banks has undergone huge changes, and various interest rate changes have increased their impact, so the calculation of interest rate risk has become more and more important. Since the VaR (value at risk) calculation method is suitable for different market conditions and accuracy requirements, and GARCH model (Autoregressive conditional heteroskedasticity model) can describe the time-varying characteristics of financial time series and improve the accuracy of VaR, dynamic VaR method and GARCH model can be combined to calculate the interest rate risk of commercial banks [9]. First of all, VaR is a measurement method developed in the early 1990s to calculate the market risk of financial assets caused by market price fluctuations through modern mathematical statistics technology [10]. GARCH model was proposed by Bollerslev in 1986. This model can describe the clustering of variance changes of financial time series. It solved the problem caused by the second assumption (constant variance) of time series variables in traditional econometrics, and then gradually formed a series of GARCH models such as TARCH and EGARCH [9]. In recent years, a growing number of studies have combined the two approaches. Cao Zhipeng and Wang Xiaofang studied the reporate of pledged bonds and established a C-VaR measure model of interest rate risk based on the ARMA-GARCH model [11]. Xu guanglin compared the accuracy of VaR calculated by GARCH model based on normal distribution and t-distribution with EWMA method, DeL ta normal method and history method in the measurement of out-of-sample dynamic VaR values, and concluded that EWMA and IGARCH (1,1)-N model can carry out more accurate measurement [12]. Specific empirical steps are as follows: (1) Data selection and analysis—normality test, stationary row test, autocorrelation test and conditional heteroscedasticity test are carried out to effectively analyze the bond repurchase rate yield and summarize its characteristics; (2) Construct GARCH model, such as EGARCH(1,1)-Gmodel formulation; 3.VaRmeasurement and backtest, however, GARCH(1,2) -N and TARCH(1,2) -N models may underestimate interest rate risk and fail to pass the backtest [9].

3.2 CIR Model and VASICEK Model

CIR model and VASICEK model can be used to measure the risk rate of national debt. Cox, Ingersoll&Rossproposed the CIR model. It has the advantage of incorporating risk aversion, time consumption preferences, wealth limits, factors leading to risk compensation, and a wide range of investment options. VASICEK model was proposed by VASICEK in a risk-neutral world, the process of interest rate change follows certain rules. Through the random duration calculation of the two models, we can not only get the yield data of this country's national debt, but also observe whether the mean return of long-term national debt interest rate is obvious [13]. We categorized these models in the same coding sheets (Table 1). In the categorization process, we included two aspects of Model proposer and Main Applicable issues.

4 Factors Influencing Default Rate Risk

The profitability of the subject of bond issuance: the profitability of an enterprise is closely related to its cash flow, income and net profit. The profitability, solvency and operation capacity of an enterprise are the key factors affecting default risk.

Table 1. Summary of the model

Model name	Model proposer	Main Applicable issues
KMV model	KMV, San Francisco, USA	Calculate the default risk of the bank and the default probability of the borrowing enterprise
Logistic model	Lowell Reed	The probability of occurrence can be predicted according to factors, which can be used for the influence of variables on the default risk of corporate bonds
Z model	Edward I	Reflect the credit status of the borrowing company and predict the risk of bond default
VaR model & GARCH model	Christopher Sims &Bollerslev	Calculate commercial bank interest rate risk
CIR model &VASICEK model	Cox, Ingersoll and Ross &Oldřich Alfons Vašíček	Calculate Treasury yield

4.1 The Profitability of the Issuer

The more competitive the bond issuer will be. Profitability can be used as the core factor to evaluate bond default risk, in order to avoid the impact of the business scale of bond issuance and the main business of the subject of bond issuance. Demirtas and Cornaggia concluded in their study of bonds in the United States from 1980 to 2003 by using Moody's rating that when the liquidity of non-core business of an enterprise is positively correlated with the default risk of bonds, when the solvency of an enterprise is investigated, The profit margin and net asset ratio of an enterprise will be the main targets for investigation, because the default risk of an enterprise cannot be fully evaluated by the non-main business of the enterprise [14]. Vivian et al., which indicates that the stronger the profitability of the company, the stronger the liquidity of the company's cash flow, the greater the possibility of debt repayment, and the lower the default risk [14].

4.2 Solvency

Generally speaking, solvency can be divided into short-term solvency and long-term solvency, and solvency will be used as the main data to investigate the financial status and profitability of enterprises. Ali and Zhang further confirmed through research that when the default risk of an enterprise is at a critical point, the bond issuer tends to increase the debt paying ability of the enterprise, thus improving the default risk of the enterprise and thus reducing it [15]. When the short-term debt paying ability of an enterprise is inversely proportional to its financial risk, that is to say, the short-term debt paying ability of an enterprise is strong and the financial risk is small, the default risk of bonds will also be reduced. On the contrary, the long-term solvency of enterprises is a test of the asset-liability ratio of the subject of debt issuance. The increase of default risk

will increase with the increase of asset-liability ratio of enterprises. Li indicated that the higher the financial leverage of the enterprise, the greater the pressure of the debtpayer, and the greater the risk of default [14].

4.3 Operation Capacity

The operation capacity of an enterprise refers to the turnover days of funds and the ability to utilize assets. The operation ability of an enterprise is mainly to measure the management of a bond subject. Elbannan studied the relationship between enterprise internal operation and enterprise default risk through data from 2003 to 2007, and found a positive correlation between the two [15]. Xu Hao and Jiang Chao believe that the turnover of working capital of an enterprise directly reflects the operation capacity of the enterprise. The better the operation capacity of an enterprise is, the lower the probability of default risk of bonds will be. On the contrary, the lower the operation capacity of an enterprise is, the longer the capital turnover time of the enterprise is, the higher the default risk of bonds will be [14].

5 Factors Influencing Interest Rate Risk

5.1 Market Competition Structure

The dealer model calculates net interest margin. The model can be concluded that the market competition structure represents the competitiveness of commercial banks in the industry and when the market concentration of commercial banks is smaller, the monopoly is higher, and the net interest margin of commercial banks is larger [16].

5.2 Transaction Scale

According to the dealer theory model, the higher the ending loan amount of commercial banks, the higher the level of net interest margin, and the two are positively correlated. So the bigger the deal, the greater the risk [17].

5.3 Macroeconomic Condition

Economic development is uncertain. If commercial banks fail to respond to the changes of economic policies in time, they will cause serious imbalance of their assets and liabilities, resulting in great interest rate risk and loss of their own interest income. At the same time, there is a certain delay between policy transmission and business adjustment, which will affect the risk of commercial banks. In addition, macroeconomic variables in the theoretical model will also affect the net interest margin of commercial banks as exogenous variables, mainly including economic growth rate and inflation rate [16].

6 Conclusion

This article studies the credit risk and interest rate risk of bonds based on 15 literature reviews. The results showed that the main evaluation models for the default risk comprise of the KMV model, Logistic model and ZETA model. While for the risk of interest rate, VaR model, GARCH Model, CIR model and VASICEK model are the mainstream models to evaluate interest rate risk of bonds. On the other hand, it is found that the profitability, debt paying ability, operating ability impose a great effect on the default risk of bonds; those four factors including market competition structure, transaction scale, whereas the three factors consisting of market competition structure, transaction scale and macroeconomic conditions have a big effect on the risk of interest rate. This paper provides some reference for scholars who study the measurement and influence factors of bond risk.

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