Decision Analysis on Operation of Commercial Banks Based on the Application of Credit CDS

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Abstract. Affected by the new crown epidemic, it is difficult for Chinese small and medium-sized enterprises to ensure the normal operation of the industrial chain in terms of business operation and development, which may lead to the inability to repay their loans in commercial banks in time, triggering credit default incidents. CDS is a new credit derivative instrument, which can alleviate the default risk held by creditors to a certain extent and enhance the trust of both borrowers and lenders. This paper tries to apply the CDS mechanism to the Chinese market, using the TOPSIS model to score some companies, and explore what types of corporate loans commercial banks need to use CDS products for risk mitigation. It is found that enterprises with poor profitability, small development prospects, high credit risk and weak solvency need to pay special attention to bank loans.

Keywords: Credit Risk, Commercial Bank, CDS, Credit Default.

1. Introduction

With the gradual expansion of the trend of economic globalization and the increase of the capacity of the world economy, the development of financial markets presents uncertainty. Financial market participants actively promote innovation and upgrading of financial products in order to mitigate risks, maintain market stability. Credit Default Swap(CDS) is a kind of credit derivative, which is a kind of contract signed by both parties of a transaction[1]. The seller and the buyer carry out risk conversion on the credit event of a designated reference entity. The reference entity is generally a third party other than the parties to the contract, either as a single asset or as a portfolio of assets. Credit default swaps originated from the developed western financial markets in the 1990s. So far, it has become one of the most important credit derivatives in the international financial market.

At present, China's economy is showing a downward trend, the non-performing loan rate of mainstream commercial banks is still high, all kinds of small, medium and micro-sized enterprises are facing serious financing difficulties, and there are numerous default events in the credit debt market. Therefore, it is necessary to introduce effective risk mitigation tools[2]. At present, CDS in our country are still in the early stage of development, so we need more reasonable pricing model to support their development.

2. Literature Review

CDS pricing can be mainly divided into reduced and structured models. Gao Jun(2013)[3]pointed out in the Pricing Study of Credit Derivatives that the structural model mainly considers the relationship between enterprise asset value and default, but has some shortcomings, such as not considering the possibility of early default and too simple assumption of enterprise capital structure. However, the reduced model regards the default probability as an exogenous variable, which can be determined by the parameters obtained in the market, which is relatively simple and convenient to describe the default intensity. Based on the pricing principle of credit default swaps, Yang Li(2019)[4]constructed a pricing model based on KMV and Copula function, and used GARCH model to fit the stock price volatility when using KMV to construct the marginal distribution of default. When the Copula function is used to construct the joint distribution of defaults, the Vine-Copula function is introduced to describe the default correlation structure among the reference entities. Zou and Guo(2020)[5]constructed the CDS pricing model of Internet consumer credit including credit rating migration under the structural framework and combined with the characteristics of Internet consumer credit. Tong and Zhou(2019)[6]took small and medium-sized enterprises as the main body and studied the impact of credit risk on the credit financing of small and medium-sized enterprises under the concept of credit default swap. In terms of pricing methods, Bielecki and Rutkowski(2010)[7]also distinguished structured models from reduced models in Credit Risk:Modeling, Valuation and Hedging: The structural model assumes that the value of corporate assets is known, so credit default is an observable event in this model. In contrast, the reduced model treats credit default as a completely unpredictable event, which is regarded as the first jump of a jump process. Based on the above literature, the structural model needs to assume that the value of corporate assets is a known process, but in practice, it is difficult to directly observe corporate assets and consider the impact of macro variables on corporate defaults. In the framework of the reduced model, the default probability is obtained only by modeling the default intensity, and then the relevant calculation is carried out according to the obtained default probability.

3. The construction of CDS scoring model

3.1. Determining Weight by Entropy Method

3.1.1 Matrix normalization

Assuming that there are j evaluation indicators and I samples, the original data evaluation matrix x is constructed:

$$X_{i\times j} = \begin{pmatrix} x_{11} & \cdots & x_{1j} \\ \vdots & & \vdots \\ x_{i1} & \cdots & x_{ij} \end{pmatrix} \tag{1}$$

$$X_{i\times j} = \begin{pmatrix} x_{11} & \cdots & x_{1j} \\ \vdots & & \vdots \\ x_{i1} & \cdots & x_{ij} \end{pmatrix} \tag{2}$$

Through observation, it can be seen that the data types of the 12 indicators are different, and there are two types: maximum type and minimum type. In order to simplify the calculation, the original matrix is first normalized, i.e. all the indicator types are converted to maximum type. If y is the normalized value, the conversion formula is, and the normalized matrix is y:$y = \max - x_i$,

$$Y_{i\times j} = \begin{pmatrix} y_{11} & \cdots & y_{1j} \\ \vdots & & \vdots \\ y_{i1} & \cdots & y_{ij} \end{pmatrix} \tag{3}$$

$$Y_{i\times j} = \begin{pmatrix} y_{11} & \cdots & y_{1j} \\ \vdots & & \vdots \\ y_{i1} & \cdots & y_{ij} \end{pmatrix} \tag{4}$$

3.1.2 Matrix standardization

Observation shows that the dimensions of the 12 indicators are different, so the normalized matrix needs to be standardized. The normalized matrix is x, the normalized matrix is z, and each element in z:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^{2}}} \tag{5}$$

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^{2}}} \tag{6}$$

3.1.3 Calculating the information entropy of an index

After observing the standardized matrix Z, it can be seen that all of them are greater than 0, therefore$Z = Z^*$. Assuming that the probability is p, then:

$$p_{ij} = \frac{z_{ij}^{*}}{\sum_{i=1}^{n} z_{ij}^{*}} \tag{7}$$

$$p_{ij} = \frac{z_{ij}^{*}}{\sum_{i=1}^{n} z_{ij}^{*}} \tag{8}$$

The calculated probability moment p is thus obtained. Because of this$\sum_{i=1}^{n} p_{ij} = 1$, the probability sum corresponding to each indicator is guaranteed to be 1.

For the j-th indicator, the calculated information entropy is:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^{n} p_{ij} \ln(p_{ij}) \tag{9}$$

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^{n} p_{ij} \ln(p_{ij}) \tag{10}$$

3.1.4 calculating the entropy weight of the index

The utility value of information is$d_j = 1 - e_j$, the greater the value, the more corresponding information. Normalizing the information utility value, and calculating to obtain the entropy weight of each index as follows:

$$W_j = \frac{d_j}{\sum_{i=1}^{n} d_j} (j = 1,2\cdots,m) \tag{11}$$

$$W_j = \frac{d_j}{\sum_{i=1}^{n} d_j} (j = 1,2\cdots,m) \tag{12}$$

3.2. Multi-attribute decision-making model (TOPSIS)

BP neural network is back propagating, mainly composed of three parts: input layer, middle layer and output layer. The number of nodes in the input and output layers is relatively easy to determine[8], but the determination of the number of nodes in the hidden layer is a very important and complex problem.

The basic steps to build the TOPSIS model are:

Constructing a weighted standardized decision matrix

$$Z_{i\times j}=\begin{pmatrix} z_{11} & \cdots & z_{1j} \\ \vdots & & \vdots \\ z_{i1} & \cdots & z_{ij} \end{pmatrix} \tag{13}$$

$$Z_{i\times j}=\begin{pmatrix} z_{11} & \cdots & z_{1j} \\ \vdots & & \vdots \\ z_{i1} & \cdots & z_{ij} \end{pmatrix} \tag{14}$$

Where m is the number of indicators and n is the number of samples.
Calculating Ideal Solution and Negative Ideal Solution

$$Z^{+}=\left(Z_1^{+},\ Z_2^{+},\cdots,\ Z_m^{+}\right)=(\max\{z_{11},z_{21},\cdots,z_{13,1}\}, \max\{z_{12},z_{22},\cdots,z_{13,2}\},\cdots,\max\{z_{1,12},z_{2,12},\cdots,z_{13,12}\}) \tag{15}$$

$$Z^{-}=\left(Z_1^{-},\ Z_2^{-},\cdots,\ Z_m^{-}\right)=(\max\{z_{11},z_{21},\cdots,z_{13,1}\}, \max\{z_{12},z_{22},\cdots,z_{13,2}\},\cdots,\max\{z_{1,12},z_{2,12},\cdots,z_{13,12}\}) \tag{16}$$

$$Z^{+}=\left(Z_1^{+},\ Z_2^{+},\cdots,\ Z_m^{+}\right)=(\max\{z_{11},z_{21},\cdots,z_{13,1}\}, \max\{z_{12},z_{22},\cdots,z_{13,2}\},\cdots,\max\{z_{1,12},z_{2,12},\cdots,z_{13,12}\}) \tag{17}$$

$$Z^{-}=\left(Z_1^{-},\ Z_2^{-},\cdots,\ Z_m^{-}\right)=(\max\{z_{11},z_{21},\cdots,z_{13,1}\}, \max\{z_{12},z_{22},\cdots,z_{13,2}\},\cdots,\max\{z_{1,12},z_{2,12},\cdots,z_{13,12}\}) \tag{18}$$

The Euclidean distance and the relative closeness score are calculated
Define the distance between the first evaluation object and as follows:i(i=1,2,…n):

$$D_i^{-}=\sqrt{\sum_{i=1}^{m} w_j (Z_j^{-}-z_{ij})^2} \tag{19}$$

$$D_i^{-}=\sqrt{\sum_{i=1}^{m} w_j (Z_j^{-}-z_{ij})^2} \tag{20}$$

An unnormalized score for the first evaluation was calculated$S_i=\frac{D_i^{-}}{D_i^{+}+D_i^{-}}$ i(i=1,2,…n). According to the above steps, the scores of N evaluation objects are calculated and normalized by using SPSS, and the CDS scores of the selected enterprises are sorted in descending order.

4. Data Selection

In this paper, 13 enterprises are selected as samples, which are marked as ~, as shown in the following figure:$\mathbf{A_1}$～$\mathbf{A_{13}}$, as shown in Table.1.

Table.1. Enterprises samples

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
Vanke	Financial Street	sunlight	Chang'an	Yuanxing	FAW Group Corporation	BYD	east wind	SAIC Motor Corporation Limited	Golden	green	New Austria	Metro

5. Indicator selection

We select some of the indicators, as is shown in table.2.

Table.2. Indicator explanation

ROA	Refers to the ratio of the total net profit of the enterprise to the average total assets of the enterprise
Profit before interest and after tax	Profit after deduction of income tax but without deduction of interest
Rate of return	Refers to the ratio of the total annual net income of the investment scheme to the total investment of the scheme in a normal year after the investment scheme reaches a certain designed production capacity.
Trading on equity	The regulation between the change rate of earnings per share of common stock and the change rate of earnings before interest and tax.
Operating leverage	The regulation that the change rate of profit is greater than the change rate of production and sales due to the existence of fixed costs in the production and operation of enterprises.
Integrated lever	The influence of changes in earnings per share of common stock.
liquidity ratio	Ratio of current assets to current liabilities.
Quick ratio	Refers to the ratio of quick assets to current liabilities of an enterprise
Asset-liability ratio	Refers to the ratio of total corporate liabilities to total corporate assets.
Capital appreciation rate	Refers to the ratio of the ending owner's equity after deducting objective factors to the beginning owner's equity.
Total assets growth rate	Refers to the ratio of the increase in total assets at the end of the year to the total assets at the beginning of the year.
Sustainable growth rate	Refers to the growth rate that would be achieved if new shares were not issued and operating efficiency and financial policies were not changed.

6. Results

6.1. Calculating entropy value and entropy weight of each index

According to the above calculation formula, the entropy value and entropy weight of each index are obtained by SPSS programming, as shown in Table.3. and Table.4.

Table.3. Indicator weight

index	Capital appreciation rate b	Total assets growthb	Sustainable growth rate	Net profit margin on total assets (ROA)A)	Profit before interest and after tax	rate of return
Information entropy value e	0.9983	0.9411	0.9683	0.949	0.7603	0.9413
Information utility value d	0.0017	0.0589	0.0317	0.051	0.2397	0.0587
Weight coefficient w	0.0033	0.1133	0.061	0.0981	0.4614	0.1131

Table.4. Indicator weight

index	liquidity ratio	quick ratio	Asset-liability ratio	trading on equity	operating leverage	Integrated lever
Information entropy value e	0.9796	0.9822	0.992	0.9839	0.9957	0.9888
Information utility valuedd	0.0204	0.0178	0.008	0.0161	0.0043	0.0112
Weight coefficient w	3.92%	3.43%	1.54%	3.10%	0.84%	2.15%

6.2. Calculate and rank the risk scores of each enterprise

By calculating the ideal solution and the negative ideal solution, the Euclidean distance and the relative closeness, the scores of the N evaluation objects are finally obtained and normalized. See Table.5. for some results after descending order:

Table.5. Corporate CDS Score and Ranking

ranking	Enterprise code	score
1	A9	0.297000297
2	A1	0.269082269
3	A11	0.143748144
4	A10	0.066825067
5	A13	0.062370062
6	A7	0.046926047
7	A4	0.042768043
8	A12	0.025839026
9	A2	0.021978022
10	A5	0.013662014
11	A6	0.008613009
12	A8	0.001188001
13	A3	0

For the calculation results, we classify the sample enterprises into three categories based on the score, as shown in the following table.6.

Table.6. Corporate Classification

High risk	Moderate risk	Low risk
A9, A1, A11	A10, A13, A7, A4, A12, A2, A5	A6, A8, A3

It can be seen that the evaluation scores of companies A9, A1 and A11 are on the high side, all higher than 0.1, which indicates that these companies have high credit risk. When facing the credit loans of these companies, banks should be more cautious and sign CDS contracts with corresponding reference assets to mitigate the risk; The enterprise evaluation scores of A10, A13, A7, A4, A12, A2 and A5 are in the middle position, indicating that such enterprises have medium credit risk. When facing the credit loans of such enterprises, the bank can analyze the comprehensive indicators of the enterprises according to the actual situation and finally decide whether to sign a CDS contract or not; As for the A6, A8 and A3 enterprises, their credit risk is relatively low, indicating that they have good reputation in their daily operations and do not have too many risk records such as loans overdue and bad debts[9]. Banks can be more confident when facing loans from these enterprises and do not have to worry about credit default events. Through empirical research, we found that credit CDS is more suitable for enterprises with poor profitability, small development prospects, high reputation risk and weak solvency. When this type of enterprise makes credit loans, banks should sign credit-type CDS contracts to mitigate the possibility of default on the reference assets. At the same time, we found that after signing the credit CDS contracts, the banks' risk concern index for the credit loans of such enterprises was reduced, and they were more willing to lend the funds to the corresponding enterprises than before. This also alleviated the problem of insufficient loans for small and medium-sized enterprises to a large extent[10], and solved the financing difficulties of small and medium-sized enterprises to a certain extent, so that they could obtain more development possibilities and confidence.

7. Conclusions

In recent years, China's economy has shown a downward trend, the non-performing loan rate of mainstream commercial banks is high, and default events in the credit bond market are frequent. More effective and proactive tools are needed to prevent and control credit problems. This paper combines the characteristics and functions of CDS with the current development status of credit derivatives in China. Under the framework of reduction method, it applies conditional independence method and multiple default time concepts, and considers the pricing of China CDS with or without counterparty risk.

With the development of social economy, the financing demand of enterprises is constantly increasing. Among many financing channels, bank loan is one of the most important financing channels for enterprises. However, due to the influence of the nature of the enterprise itself, commercial banks currently have many risk problems when they launch enterprise credit business, which will bring certain economic losses to commercial banks. Therefore, the introduction of credit CDS is beneficial to commercial banks to control the risks. In this paper, the entropy method is adopted to comprehensively analyze the profitability, risk level, solvency and development ability of enterprises based on the TOPSIS model, and the credit CDS are scored. the types of enterprises suitable for credit CDS are analyzed, which are more suitable for enterprises with poor profitability, small development prospects, high reputation risk and weak solvency. In the event of a default on a credit contract, it would be better for commercial banks and businesses to hold a CDS contract. This paper makes a theoretical research on the application of CDS in commercial banks, which contributes to the promotion of the application scope of CDS and provides more research on the prevention of default risk in credit, and has certain reference significance.

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