

CRM Pricing Research of China's Inter-bank

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Abstract—Credit risk mitigation (CRM) is an effective mean for bank's credit risk transformation. Buying CRM can reduce bank's capital requirement, and meet Basel regulatory agreement effectively. China's implementation of CRM will help improve the credit risk-sharing mechanisms, solve the "paradox of credibility" effectively and raise the proportion of direct financing. In this paper, the idea of credit spread is used to price CRM, in which the main parameters processed by KMV model. Through pricing 11 Agriculture CP01 CRM, this paper provides some references for China's CRM pricing research.

Keywords-Credit risk mitigation; Credit spread; KMV

I. INTRODUCTION

Derivative market embraced its boom from 1990s in western developed countries. Although in some level, the over speculation and lack of inspection lead to the recent financial crisis, the derivative market is important to a robust financial market. And it plays key roles in risk management for financial institutions. Compared to the prosperous derivative market in western developed countries, the derivative market in China is far behind in instrument diversity, market volume and innovation. Now, the loan market in China has a value of 40 trillion RMB, and in terms of whole value the bond market ranked as the second in Asia and sixth globally. However, there is no derivative that can be used for risk management effectively. The introduction of credit risk mitigation (CRM) tools is a breakthrough for this scenario. During 2011 and 2012, big commercial banks in China will apply Basel II (known as the New Basel Accord). The introduction of credit risk mitigation tools as a necessary premise to application of Basel II also will push this process. The pricing of CRM is essential and difficult point, and this paper can provide some theoretical guidance to derivative market in China.

II. THE DEVELOPMENT OF CRM

A. Introduction and development globally

CRM is the employment of various methods to reduce the risks to lenders, banks and other business which offer credit. The methods can include risk based pricing, or adjusting the cost of credit according to the credit strength of the borrower; credit tightening, or reducing the amount of credit available to higher risk applicants; diversification, or increasing the portfolio mix of borrowers and purchasing credit insurance.

With the development of risk management, Basel committee place more importance on CRM which is reflected in a series of rules and files as showed in Tab.I. The 2006 new capital accord recognized CRM as eligible capital which can substitute capital requirement by Basel Accord. This file determined eligible CRM and built comparably complete CRM management outline technically.

TABLE I. The Historical Evolution of the Credit Risk Mitigation Techniques

Time	Title	Main content
Jul 1988	International convergence of capital measurement and capital standards	Recognized the importance of mortgage and guarantee to reduce credit risk ; no agreeable standard about eligible mortgage; no discussion about the credit risk mitigation effect of derivatives
Jan 1999	Bank and other highly levered institution trading guidance	Banks need to be cautious about the other risk mortgage brings when mitigating credit risks.
Jun 1999	New capital accord (a draft for discussing) (the first draft)	Recognized risk management effect of financial instruments except derivatives
Jan 2001	New capital accord (a draft for discussing) (the second draft)	Introduced the credit mitigation tech system; allowed banks to take the mortgage into account when calculating default rate
Apr 2003	New capital accord (a draft for discussing) (the third draft)	Detailed defined CRM; in internal audit, banks can consider the derivatives using internal ratings-based approach
Jun 2004	International convergence of capital measurement and capital standards	To perfect CRM tech system, there are more specific requirement in terms of mortgage, risk weight, information disclosure and etc.
Jun 2006	New Basel Accord	CRM are defined as mortgaged guarantee, credit derivatives and netting settlement
Dec 2009	Principle of risk management and regulation	Risk management using a series of instruments

Source: filing released by the Bank for International Settlements

B. Introduction and development in China

On Oct 29, 2010 National Association of Financial Market Institutional Investors issued Interbank Market CRM Tools Trial Guidance (referred as Guidance later) and Derivatives Trade Agreement. In the Guidance, CRM is referred as Credit Risk Mitigation Agreement, Credit Risk Mitigation Warrant and other basic credit derivatives used in credit risk management. The underlying financial tools in CRM are bond and bond like instruments. Given the complexity and high risk of credit derivatives, Guidance only recognizes credit default swap and total return swap as eligible CRM and the debt in CRM must be the direct debt of the credit protection provider. It requires commercial banks use CRM for credit protection instead of profit. Also there are special requirements for the settling up and loss measurement.

From this we can see CRM in China is similar to Credit Default Swap (CDS) and Total Return Swap (TRS). So far, CRM is modified CDS according to Chinese specific circumstances and “2+N” innovation. CRMA and CRMW are two core products for CRM. CRMA is the simplified CDS and CRMW is the innovatively standardized CDS which can be traded in secondary market.

The following are differences between CRM and CDS:

- Simple structure. The existing products are based on interbank liquid bonds. The design of CRM does not suffer from complicated design such as pass-through.
- Clear underlying product. The underlying product must be a clear debt which avoids unclear mess up of assets.
- Pre-report and central clearing. Uniform registration effectively controls the leverage. The central clearing avoids over speculation and over expansion of this market which keeps system risk from spreading.
- Based on the above analysis, CRM in China is a kind of credit insurance as CDS. So the pricing method of CRM is similar to that of CDS.

III. CRM PRICING METHOD AND MODEL PARAMETER

A. Pricing method

The pricing model of CDS, discounted future cash flow is a popular method. In this model, default probability, loss given default, and discount factor are important parameters. Given the complete default database for western developed countries, they can use the existing default data to value CDS. Or they can use structure model or reduced form model to price CDS. Bond and credit market in China started late, and CRM market is even a brand new thing. So the data for this market very limited which makes the discounted future cash flow method not appropriate, while credit spread method is easy to apply except it is not accurate. But the structure of CRM is simple, so credit spread method can be used here to price CRM or CDS. In this paper we use credit spread method to price CRM.

Generally, rate of return is negatively related to the credit rating grade of bonds. Low credit quality bond usually gives investor higher rate of return to compromise higher credit risk. Credit spread method uses the risk premium between different credit quality bonds of the same underlying entity. Bond holders can fix their rate of return buying CRM to transfer the risk. So the risk premium here is the price of CRM.

Price of CRM = Low quality bond rate of return – High quality bond rate of return (or risk free rate)

Assume that:

Risk free rate r ; bond interest rate i , that is the price of bond; volume of bonds: F ; bond face value F_T ; enterprise asset value: V ; expected default rate EDF; expected default loss EL ; term of bond T ; CRM price ω .

Under the assumption of no arbitrage, risk free bond has the same rate of return as risk bond.

$$Fe^{iT} = Fe^{iT}(1 - EDF) + EDF(Fe^{iT} - EL)$$

$Fe^{iT}(1 - EDF)$ is the return when debtor pays the claim;

$EDF(Fe^{iT} - EL)$ is the return when debtor defaults;

$$\therefore F_T = Fe^{iT}$$

$$\therefore F_T e^{-iT} e^{rT} = F_T(1 - EDF) + EDF(F_T - EL)$$

$$e^{(r-i)T} = 1 - \frac{EDF \cdot EL}{F_T}$$

$$\omega = i - r = -\frac{1}{T} \ln\left(1 - \frac{EDF \cdot EL}{F_T}\right) \quad (1)$$

As shown in (1), F_T and T are known, EDF and EL are two important parameters in CRM pricing which are calculated by credit risk model in this paper.

B. Model Parameter

This paper follows KMV model to calculate EDF and EL. KMV model is a credit risk model based on MM theory, Black-Scholes, and Merton model. In KMV model equity is treated as a call option on company asset. Default has the same effect as giving up the call option. The more the enterprise asset devalues, the higher the default risk, and the higher value the option has.

KMV model has several premises, and the most important one is the option pricing theory as shown below:

Assuming asset price follows logarithm normal distribution, and trading is consecutive and there is no trading fees, taxes, or paid bonus when the option is effective. Also the risk free rate is assumed to be a constant.

$$E = VN(d_1) - De^{-r\tau}N(d_2) \quad (2)$$

Hereinto,

$$d_1 = \frac{\ln\left(\frac{V}{D}\right) + \left(r + \frac{1}{2}\sigma_A^2\right)\tau}{\sigma_A\sqrt{\tau}}$$

$$d_2 = d_1 - \sigma_A\sqrt{\tau}$$

E is the price of call option, which is the equity value of a company; D is the market value of company bonds; τ is the term of bond; r is risk free rate; V is market value of enterprise asset, σ_A is the volatility of asset value.

Also we also know that

$$\sigma_E = \rho_{E,A} \sigma_A = \frac{V}{E} \cdot \frac{\partial E}{\partial V} \cdot \Delta \cdot \sigma_A \quad (3)$$

σ_E is the standard error of equity return; ρ_{EA} is the elasticity of equity value to company asset; Δ is option hedge ratio, that is $N(d_1)$.

$$\therefore \sigma_E = \frac{N(d_1)V}{E} \sigma_A \quad (4)$$

From (3) and (4), we can get V and σ_A .

- Default point (DP)

One premise of KMV model is that the company will default when asset value is lower than such a level. This level is defined as default point. Based on more than 4,000 companies analysis, KMV company get the following formula of default point:

$$DP = STD + 0.5LTD \quad (5)$$

STD is liquid debt and LTD is long term debt;

- Default distance (DD)

Default distance is how many standard errors it needs to devalue to default point. In KMV model, default distance is the indicator used to measure default risk. The higher the DD is, the higher ability company has to pay off debt and the lower credit risk the company has. The formula is as following:

$$DD = \frac{E(V) - DP}{E(V)\sigma_A} \quad (6)$$

- Expected default frequency (EDF)

EDF is used to indicate the default probability of a company in the future in KMV model. The formula to calculate EDF:

$$\begin{aligned} EDF &= \Pr(E(V_1) < DP) \\ &= N[(DP - E(V_1)) / (E(V_1)\sigma_A)] = N(-DD) \end{aligned} \quad (7)$$

- Expected loss

Expected loss = Loss Given Default \times Exposure at Default

The above gives explanation about the parameter in the model we used in this paper.

IV. CREDIT RISK MITIGATION PRICING EMPIRICAL ANALYSIS

A. pricing entity choice

The KMV model is appropriate in pricing short term asset. And the time series data we choose is from Jan 2010 to Dec 2010. So we choose the first round short term financial bonds of Heilongjiang Agriculture Company Limited as underlying assets which is shown in Tab.2. Heilongjiang Agriculture Company Limited is a public company with high

credit rating. As a leading company in this industry, it is appropriate to meet the KMV analysis standards.

TABLE II. THE BASIC INFORMATION OF THE FIRST ROUND SHORT TERM FINANCIAL BONDS OF HEILONGJIANG AGRICULTURE COMPANY LIMITED IN 2011

Name	the first round short term financial bonds of Heilongjiang Agriculture Company Limited in 2011		
Bond ticker	1181011	End of issue day	2011-01-13
Issue date	2011-01-13	Issue market	Interbank market
Public date	2011-01-14	Issue company	Heilongjiang Agriculture Company Limited
Volume (trillion RMB)	5.0000		
Face value (RMB)	100.00	Repayment of capital and interest	Fixed interest
Issued price	100.00	Issuance ways	Dutch bidding
Term (year)	1	Maturity date	2012-01-13
Yearly interest rate (%)	4.43	Credit rating	A-1

B. 4.2 Empirical calculations

1) Default point calculation

Tab.3 shows part of Heilongjiang Agriculture Company Limited's balance sheet with a total debt of 12030641425 RMB, in which 11158108773 RMB is short term debt and 872532652 RMB is long term debt.

As calculated in formula (5):

$$DP = STD + 0.5LTD = 11158108773$$

TABLE III. THE AGRICULTURE DEBT UNIT: RMB

Short term debt	amount	Long term debt	Amount
Short term loan	7127195897	Long term loan	12257152
Notes payable	77200000	Bonds payable	800000000
Account payable	1083052106	Long term payable	137271.31
Deposits received	2156364898	Other illiquid debt	60138228
Wages payable	252295980.1	Total long term debt	872532652
Taxes payable	-637417337.1		
Interest payable	33108522.98		
Bonus payable	387613.38		
Other payables	1065921093		
Total short term debt	11158108773		

2) Default distance calculation

a) Standard error of equity return calculation

Heilongjiang Agriculture Company Limited has a volume of 1777679910 shares of equity. Based on history volatility model, we assume share price follow logarithm normal distribution, then we can get the daily rate of return:

$$\mu_i = \ln(S_i / S_{i-1})$$

S_i is the closing price on the i^{th} day, and then the daily rate of return standard error is:

$$\sigma'_E = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (\mu_i - \bar{\mu})^2}$$

$\bar{\mu}$ is the expectation of daily rate of return, that is $\bar{\mu} = \frac{1}{n} \sum_{i=1}^n \mu_i$

Given the number of trading days, the yearly standard error is $\sigma_E = \sigma'_E \sqrt{T}$

With 235 trading days, Heilongjiang Agriculture Company Limited has a 0.121789 yearly volatility. The standard error of equity rate of return is 0.348983.

b) Value of equity

The average share price of Heilongjiang Agriculture Company Limited during 2010 is 13.64 RMB. With 1777679910 shares, the market capitalization is 24247553972.4 RMB.

c) Asset value volatility

Solve the following nonlinear function group

$$\because E = VN(d_1) - De^{-rt}N(d_2)$$

$$\sigma_E = \frac{N(d_1)V}{E} \sigma_A$$

$$d_1 = \frac{\ln\left(\frac{V}{D}\right) + \left(r + \frac{1}{2}\sigma_A^2\right)\tau}{\sigma_A \sqrt{\tau}}$$

$$d_2 = d_1 - \sigma_A \sqrt{\tau}$$

With $DP = 11594375098$, $E=24247553972.4$, $\tau = 1$ year, and $\sigma_E = 0.348983$, we can get

$$\sigma_A = 0.238, V = 35556000000$$

Then with (6), we get a $DD = 2.8316$

3) EDF and EL calculation

From (7), we know $EDF = N(-DD) = 0.0023$

In this paper we use loss given default gathered by Chinese scholars to calculate expected loss as showed in Tab.4. LGD for Heilongjiang Agriculture Company Limited is 30.57% since it is credit debt.

TABLE IV. THE LGD VALUATION

Type of bond	Mortgaged debt	Secured debt	Mortgaged and secured debt	Credit debt
LGD	34.76%	37.10%	34.05%	30.57%

So, $EL = LGD * EAD = 152850000$ RMB

4) CRM pricing

From (1), we know that

$$\omega = i - r = -\frac{1}{T} \ln\left(1 - \frac{EDF \cdot EL}{F_T}\right) = 0.0007$$

So the price of CRM which is based on the first round short term financial bonds of Heilongjiang Agriculture Company Limited in 2011 is about 7 basis points.

V. CONCLUSIONS

Credit spread method can make the CRM pricing process simpler, and KMV model can reduce our dependence on history data. Such combination is appropriate for the current state of market in China. The scale of CRM market now is relatively small in its beginning period. To perfect this market, we need to build central clearing system, promote trading standardization, and improve the concentration of information. But also, the regulation cannot be too heavy which may suppress the market development. It needs to take step by step to enrich the derivative market focusing on simple and interbank product first.

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