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Feasibility of Valuing Credit Risk in the Financial Market in Sri Lanka: a case study

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Abstract: The Sri Lankan financial market uses non analytical techniques to quantify credit risk. Credit derivatives are not used to transfer credit risk. A Credit Default Swap (CDS) is the most widely used credit derivative to manage credit risk. To evaluate the price of CDS, various sophisticated methods are used. This research paper focuses on techniques to hedge credit risk in the Sri Lankan financial market, the behaviours of CDS in derivative markets, calculating a fair value of CDS, the main advantages of using credit derivatives, and major imperfections to use the pricing process of CDS in the Sri Lankan market.

Keywords: Financial market, Credit risk, Credit Default Swaps (CDS)

Introduction

In the late 1980s credit risk management in the world's financial market became a significant issue. Credit risk management has become the main risk management area in the Sri Lankan financial market due to a higher share of loans and advances from the total assets portfolio of financial institutes.

The task of handling credit risk in the Sri Lankan financial market is basically bound by the use of some qualitative methods and simple mathematical models. The main techniques currently in use in Sri Lanka to manage credit risk are: an internal rating system of Basal II, the implementation of a rating system and independent credit risk assessments. Furthermore, some strategies used to hedge credit risk are:

- a statement of the bank's willingness to grant loans based on the type,
- Identification of target markets and business sectors, preferred levels of diversification and concentration,
- The cost of capital in granting credit and bad debts, and the cyclical aspects and the resulting shifts in the composition and quality of the loan portfolio under the supervision of the Central Bank of Sri Lanka (Central Bank of Sri Lanka report, 2011).

In addition to qualitative methods, several mathematical models are used to evaluate credit risk. Linear Discriminant Models and Credit scoring models are primarily used methods to value credit risk.

Linear Discriminant Models divide borrowers into high or low default risk classes, based on observed characteristics (X_1) and past data. One such model is Altman's Z score which uses financial ratio and weights to arrive at a score.

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \quad [1]$$

where,

X_1 = working capital / total assets

X_2 = Retained earnings/ total assets

X_3 = Earnings before interest and taxes/ total assets

X_4 = Market value of equity/ Book value of long term debt

X_5 = sales/ total assets

The weights are based on observed experiences of defaulting and non defaulting borrowers derived from a model. If the score is less than 1.81 it is considered as a high default risk, between 1.81 and 2.99 a moderate risk and above 2.99 is low risk.

In Credit scoring models, observed characteristics of income, age, relationship with financial institute, etc are used to calculate a "score" for a borrower. If the score is below the pre determined level, the loan is rejected. Two main broad types of credit scoring models are listed herein.

Linear probability model

Past data (e.g. financial ratios) are used as inputs to explain the repayment on past loans. The coefficients are then used to predict future repayments.

$$PD_i = \sum \beta_j X_{ij} + error \qquad [2]$$

Logit model

This model has overcome the above weakness restricting PDs to lie between 0 and 1. The following formula can be used to calculate the risk.

$$PD_i = 1/(1 + e^{-PD_i}) \qquad [3]$$

where PD is risk.

In a global context the most famous way to hedge credit risk is through the use of credit derivatives. A credit derivative is a financial instrument and is a privately held negotiable bilateral contract that allows users to manage exposure to credit risk. A Credit Default Swap (CDS) is the most widely used credit derivative to manage and trade credit risk. In the Sri Lankan financial market Credit Default Swaps are not used to transfer credit risk. This study focuses on the feasibility of using Credit Default Swaps in the Sri Lankan financial market, advantages of using CDS and major limitations to use calculating process of CDS in Sri Lanka.

Material and Method

The attempt, here, is to give a short description of the functionality of Credit Default Swaps in financial markets. The buyer of the CDS makes a series of payments (the CDS "fee" or "spread") to the seller and, in exchange, receives a payoff if the bond defaults. The CDS spread is normally recorded as a basis point (bps). Fig. 1 illustrates the mechanism of CDS contract (Hull, 2003).

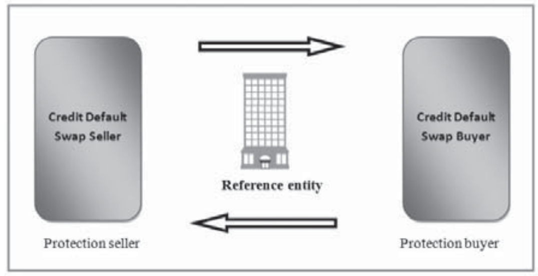

Figure 1: Mechanism of CDS

During the last few years, several studies have addressed the theoretical pricing of credit derivatives. Different approaches are used to value the price of Credit Default Swaps since modeling credit risk is a major task in the pricing process. Structural models and reduced form models and two different approaches are mainly used in the financial market to hedge credit risk.

The major difference between these two models is that, structural models assume that the default is based on the firm's property liability evaluation process and reduced form models assume that default is a stochastic event which is independent of the firm's financial position and dependent on the general level of interest rates. The choice of selecting the model often depends on the intended use and methodological preference of the user (Hull and White, 2000).

Pricing CDS means calculating default swap spread. Using Modified Market Standard Pricing Model default swap spread can be calculated (Dominic and Turnbull, 2003). The full mechanism of the model is illustrated in Fig. 2.

According to Fig. 2 there are two main steps in valuing Credit Default Swap spread.

1. value the expected present value of premium leg
2. value the expected present value of protection leg

Premium leg

A regular stream of payments made by protection buyer to protection seller until the maturity date or occurrence of credit event is called premium leg.

Protection leg

Before the maturity date of the contract if credit event occurs the payment made by the protection seller to protection buyer is called protection. If credit event does not occur during the life time of the bond no payment is made by the protection seller.

Accrued premium payment

If the credit event occurs between two premium dates the protection buyer is required to pay the fraction of premium that has accrued from the previous premium payment date to the time of credit event.

Valuing the expected present value of the premium leg with premium accrued

To calculate expected present value of the premium leg survival probabilities and discount functions should be modelled. Full value of the premium leg is given by Eq. 4.

$$PV_1(t_v, t_N) = S(t_0, t_n) \sum_{n=1}^{N} \Delta(t_{n-1}, t_n, B) Z(t_v, t_n) X$$

$$where\ X = \left[Q(t_v, t_n) + \frac{I_{PA}}{2} \left(Q(t_v, t_{n-1}) - Q(t_v, t_n) \right) \right] \qquad [4]$$

where $S(t_0,t_n)$ is initial default swap spread, $\Delta(t_{n-1},t_n,B)$ is the day count fraction between premium dates t_{n-1} and t_n in the appropriate basis convention denoted by B, $Q(t_v,t_n)$ is the arbitrage-free survival probability of the reference entity from valuation time t_v to premium payment time, t_n, $Z(t_v,t_n)$ is the Libor discount factor from valuation date to premium payment date t_n and

$$I_{PA} = \begin{cases} 1 & \text{if the contract specifies premium accrued (PA)} \\ 0 & \text{if the contract does not specifie premium accrued (PA)} \end{cases}$$

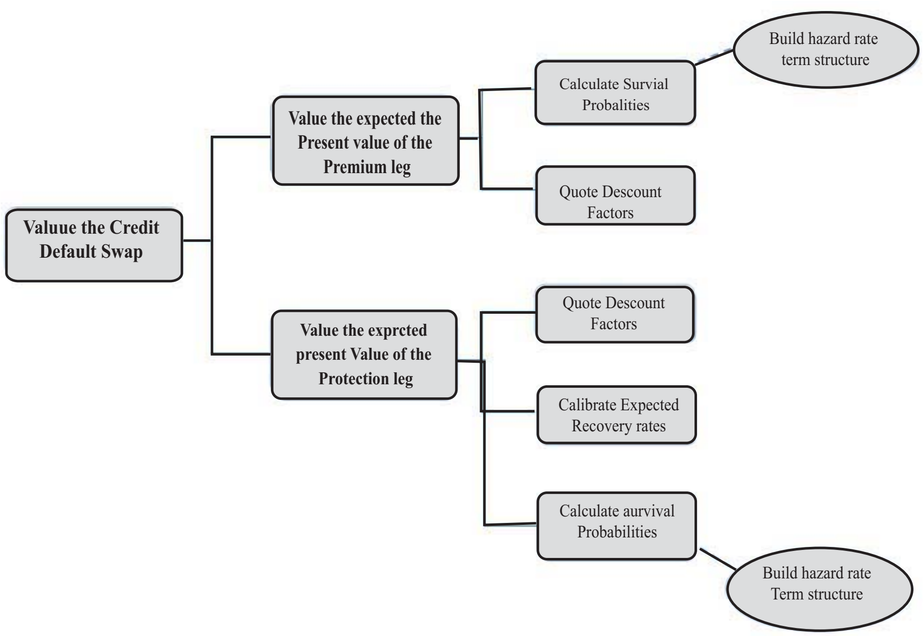

Figure 2: Market Standard Pricing Model

Calculating survival probabilities

The credit event process can be modelled by reduced-form approach to calculate survival probabilities. In the reduced-form approach, the credit event process is modelled directly by valuing the probability of the credit event itself. A credit event is identified as the first event of a Poisson counting process in reduced-form approach by Jarrow and Turnbull in 1995. The probability of a default occurring within the time interval [t,t + dt] conditional on surviving to time t is given by

$$Pr(\tau < t + dt | \tau \geq t) = \lambda(t)dt \qquad [5]$$

where $\lambda(t)$ hazard rate is a function of time and is the length of the time interval for a default to occur.

Modeling default in a one-period setting can be explained using binomial tree with probability of default λ(t)dt and probability of surviving 1−λ(t)dt and it is illustrated in Fig. 3.

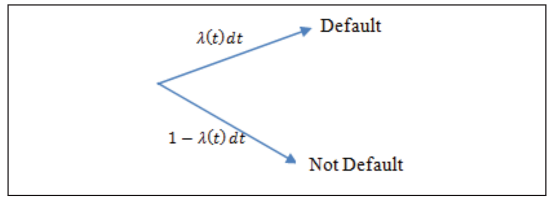

Figure 3: Binomial Tree of modelling default in a one-period setting

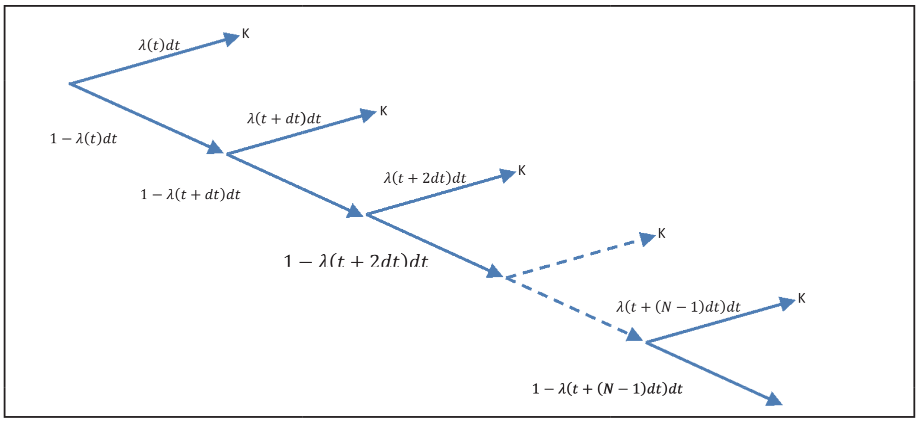

Figure 4: Binomial Tree of modelling default process

The equivalent of a binomial tree in the modeling of default in which the tree terminates and makes a payment K at default is given in Fig. 4.

Considering the limit of approaches to zero continuous time survival probability to the time T conditional on surviving to time can be calculated and it is given by Eq. 6.

$$Q(t_v, T) = \exp\left(-\int_{t_v}^{T} \lambda(s)ds\right) \quad [6]$$

Calculating Discount factors

Libor discount factors from valuation date to premium payment date n are calculated by market quoted Libor discount rates. Quarterly and monthly interest rates are needed to value the discount factors of the premium leg and protection leg. But market observed rates were available only up to 12 months. Therefore, bootstrapping method has to be used to derive those rates.

Valuing the expected present value of protection leg

A credit event can occur at anytime during the life time of CDS. The protection leg is the contingent payment of (1− R) on the face value of the protection made at the time of credit event. Here R is the expected recovery rate. The time of the credit event is important in valuing the protection leg. Considering small time interval [**s**,**s**+**ds**] between time $\mathbf{t_v}$ and $\mathbf{t_N}$ at which the credit event can occur, expected present value of protection leg can be calculated.

The expected present value of protection leg

$$PV_2(t_v, t_N) = (1-R)\sum_{m=1}^{M\times t_N} Z(t_v, t_m)\big(Q(t_v, t_{m-1}) - Q(t_v, t_m)\big) \quad [7]$$

for a default swap with maturity m=1,…,$M\times t_N$.

Calibrating expected recovery rates

Since recovery rate R is not a market observable input, data from rating agency are used to obtain the value of R.

Building hazard rate term structure

To calculate corresponding survival probabilities hazard rate term structure should be built. Here the standard modelling assumption to create the hazard rate term structure is that hazard rate function is piecewise flat.

Using market quoted CDS contracts with one year, two years, three years, four years, five years, seven years and ten years hazard rate term structure with seven sections $\lambda_{0,1}, \lambda_{1,2}, \lambda_{2,3}, \lambda_{3,4}, \lambda_{4,5}, \lambda_{5,7}$ and $\lambda_{7,10}$ can be extracted.

For one year CDS contract, Eq. 8 can be used to extract first hazard rate.

$$\frac{S(t_v,t_{v+1})}{(1-R)}\sum_{n=3,6,9.12}\Delta(t_{n-3},t_n,B)Z(t_v,t_n)e^{-\lambda_{0,1}\tau_m} = \sum_{m=1}^{12} Z(t_v,t_m)\left(e^{-\lambda_{0,1}\tau_{m-1}} - e^{-\lambda_{0,1}\tau_m}\right) \quad [8]$$

The iterative method bootstrapping is used to extract the term structure of hazard rates. One year quoted default swap spread uses to calculate the first hazard rate $\lambda_{0,1}$ and 2Y quoted default swap spread is used to calculate the second hazard rate $\lambda_{1,2}$. This procedure is repeated until final rate is extracted.

Assumptions made on the method of constructing hazard rate term structure are:

- premium payments are made quarterly frequency,
- the value of M is taken as 12,
- premium accrued is not paid,
- the hazard rates calculated here are the arbitrage-free ones,
- hazard rate remains flat beyond 10Y maturity.

Monthly discretization are
τ_0=0.0000,τ_1=0.0833, τ_2=0.1670,…, τ_{12}=1.000
Related survival probabilities are

$$Q(t_v,T)=\begin{cases}\exp(-\lambda_{0,1}\tau) & \text{if } 0<\tau\le 1\\ \exp\left(-\lambda_{0,1}-\lambda_{1,2}(\tau-1)\right) & \text{if } 1<\tau\le 2\\ \exp\left(-\lambda_{0,1}-2\lambda_{1,2}-\lambda_{2,3}(\tau-2)\right) & \text{if } 2<\tau\le 3\\ \exp\left(-\lambda_{0,1}-2\lambda_{1,2}-2\lambda_{2,3}-\lambda_{3,4}(\tau-3)\right) & \text{if } 3<\tau\le 4\\ \exp\left(-\lambda_{0,1}-2\lambda_{1,2}-2\lambda_{2,3}-2\lambda_{3,4}-\lambda_{4,5}(\tau-4)\right) & \text{if } 4<\tau\le 5\\ \exp\left(-\lambda_{0,1}-2\lambda_{1,2}-2\lambda_{2,3}-2\lambda_{3,4}-2\lambda_{4,5}-\lambda_{5,7}(\tau-5)\right) & \text{if } 5<\tau\le 7\\ \exp\left(-\lambda_{0,1}-2\lambda_{1,2}-2\lambda_{2,3}-2\lambda_{3,4}-\lambda_{4,5}-\lambda_{5,7}-\lambda_{7,10}(\tau-7)\right) & \text{if } 7<\tau\end{cases} \quad [9]$$

where $\tau = T - t_v$

Calculating the credit default swap position

Default swap spread can be found equating two expected present values $PV_1(t_v,t_N)$ and $PV_2(t_v,t_N)$.

$$PV_1(t_v,t_N) = S(t_v,t_n)\sum_{n=1}^{N}\Delta(t_{n-1},t_n,B)Z(t_v,t_n)\left[Q(t_v,t_n) + \frac{I_{PA}}{2}\left(Q(t_v,t_{n-1}) - Q(t_v,t_n)\right)\right]$$

$$PV_2(t_v,t_N) = (1-R)\sum_{m=1}^{M\times t_N} Z(t_v,t_m)\left(Q(t_v,t_{m-1}) - Q(t_v,t_m)\right)$$

By replacing valuation time t_v by t_0 price of a new contract can be found.

This method is mainly used in the followings assumptions:

- hazard rate process is deterministic,
- hazard rate is independent of interest rates and recovery rates,
- the protection leg payment is made immediately.

The algorithm of the steps of the summarized process is:

Step1: The expected present value of the premium leg for one year is calculated using survival probabilities, discount factors and market quoted default swap spread.

Step2: The expected present value of the protection leg for one year is calculated using survival probabilities, discount factors and recovery rate.

Step3: The first hazard rate is derived using Excel solver option based on the calculated expected present values of premium leg and protection leg for a year.

Step4: The process mentioned above is repeated for two years quoted default swap spread for two years to derive the second hazard rate. In the same way, the remaining five hazard rates are derived for ten years based on the calculated expected present values of premium legs and protection legs. These hazard rates are used to find survival probabilities.

Results and Discussions

In Germany sovereign Credit Default Swaps contracts are with different maturities, London Interbank Offered Rates (LIBOR), and market quoted recovery rate are used to build expected present value of premium leg and expected present value of protection leg. Some of the data points of main two legs are represented in Tables 1 and 2.

Table 1: Calculation Expected present value of premium leg

Valuation Date : 23 Feb 2012		Maturity Date: 23 Feb 2022			
Frequency : Quarterly		Basis: 365			
Payment Dates	Day Count	Interest Rate	Libor factor	Discount	Survival Probability
23-May-12	0.2465753	0.007690000	0.998113		0.997660899
23-Aug-12	0.4986301	0.010880000	0.994619		0.995275472
23-Nov-12	0.7506849	0.012660000	0.990600		0.992895750

Table 2: Calculation of Expected present value of protection leg

Payment Date	Day count	Interest rate	Discount factor	Survival 01	Survival 02	Survival probability
23-Feb-12	0					
23-Mar-12	0.079452	0.00444	0.999648	1	0.999246	0.000754309
23-Apr-12	0.164384	0.00573	0.999061	0.999246	0.99844	0.000805701
23-May-12	0.246575	0.00769	0.998113	0.99844	0.997661	0.000779092

The main advantages of using credit derivatives in the Sri Lankan market are:

- reducing the concentration risk of a credit portfolio,
- diversifying the credit portfolio with the help of new credit risks without possessing the underlying security,
- managing actively the credit risks of individual large credits while maintaining the existing client relations.

One of the main advantages of this calculating process of CDS is, that it gives the survival probabilities of a related reference entity. It shows the company's financial stability. It is a great help for investors and other parties to make their financial decisions. But there are limitations to use this calculating process in Sri Lanka.

Constraints in using the calculating process of CDS to derive survival probabilities of Companies in Sri Lanka relate to:

- Market quoted CDS prices - the main key inputs to build hazard rate term structure and to calculate survival probabilities. But CDS prices cannot be quoted from the Sri Lankan market since derivatives do not trade in the financial market,
- LIBOR interest rates - used to value two legs. But those interest rates are not suitable for the Sri Lankan market. Therefore, appropriate interest rates are needed. And finding sources to get interest rates is a difficult task.
- The model Rating agency recovery rate - data is used to get the value of . But rating agencies is biased in favour of U.S. companies, because that is where the greatest amount of standard data comes from and can, therefore, be not appropriate to Sri Lankan names. Furthermore, they are historical, not forward looking, and so fail to take into account market expectations about the future.

Conclusions

Qualitative methods like Internal rating system of Basal II and simple mathematical models currently used by financial institutions in Sri Lanka to manage credit risk cannot be considered sufficient. Credit derivatives can be used to transfer the credit risk. Market quoted default swap spreads as described in this paper can be used to model the risk. The calculating process may bring up survival probabilities that give the stability of the reference entity. For traders to identify the financial situation of a company for financial decisions, the suggested model could be of immense use in quantifying credit risk. However, this method may have practical constraints since derivatives are not directly traded or quote interest rates. Yet, the market contains financial products that can replace the quoted default swap spreads. With this method loan protections can be used to model credit risk.

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