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Credit Risk and LGD Modelling

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Abstract

This paper deals with the methods for estimating credit risk parameters from market prices, e.g. Probability of Default (PD) and Loss Given Default (LGD). Precise evaluation of these parameters is important not only for bank to calculate their regulatory capital but also for investors to price risky bonds and credit derivatives. In this paper, we introduced reduced-form analytical methods for the calculation of LGD to pricing Credit Default Swaps. Reduced-form credit risk models were introduced as a reaction to structural approach, especially trying to decrease informational difficulty when modelling credit risk. In the reduced-form approach, the market value of defaulted bonds is the same as in the fraction recovered from the exposure at default. We use the face value convention, which Hull & White (2000) presented in their model which extended recovery of face value convention for coupon bonds.

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1. Introduction

Credit risk is the oldest form of the risk in the financial market. Credit risk, or the risk that money owed is not repaid, has been prevalent in banking history. Credit risk is the most important risk type that has been present in finance, commerce and trade transactions. Credit risk techniques have undergone significant development in recent decades. This had led to the development of new methods for the estimation of the potential bankruptcy of borrowing entities and parameters specifying possible losses. These parameters include Loss Given Default.

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The LGD *"means the ratio of the loss on an exposure due to the default of a counterparty to the amount outstanding at default."* This ratio is required to be estimated by banks. Reduced-form models, unlike structural-form models, do not condition default on the value of the enterprise value not be estimated to implement them. This paper is mainly focused on reduced-form approach to pricing credit default swaps (Klieštik, Lyakin & Valášková, 2014).

2. Definition and basic characteristics of the LGD

Provide the clear and accurate definition of the default is not easy. Each financial institution can differently specify the situation where the client is already in default. Different situations which can be regarded as a failure of the debtor then offer a space to the different definitions of default. Default can be defined as delay in repayment of interest or the situation when it is clear that the risk of losses will occur (Kollár & Klieštik, 2014).

Which will be the loss in the case of partners default? It is the one of the question which is important for banks or other financial institutions. Naturally, after the less or more excepted situations that affect the financial sector and also after the development of the new financial instruments, there is fear from outstanding debts and possible debtor default.

Moody´s (2005, p.39) definition of default is "*any missed or delayed disbursement of interest or principal, including delayed payments made within a grace period, if issuer files for bankruptcy or legal receivership occur. Distressed exchange arises when (i) the issuer offered bondholders and new security that amounts to a diminished financial obligation or (ii) the exchange had the apparent purpose of helping the borrower avoid default.*

Another definition of default which was presented by BCBS (2005, p. 96) is: *"a default is considered to have occurred with regard to a particular obligor when either one of both of the following events have taken place.*

- *The bank considers that the obligor is unlikely to pay its credit obligations to the banking group in full, without recourse by the bank to actions such as realising security.*
- *The obligor is past due more than 90 days on any material credit obligation to the banking group. Overdrafts will be considered of a limit smaller than current outstanding. "*

There are also many ways to define the credit risk. The most used definition is "*credit risk is the default risk results from the unwillingness or inability to pay the debt*" (Cisko & Klieštik, 2013). There are three parameters of credit risk and also three main ingredients in Basel model II (Engelmann & Rauhmeier, 2006):

- Probability of Default, PD: is the financial term describing the likelihood of a borrower´s defaulting over a particular time horizon. It provides an estimate of the likelihood that a client of a bank or financial institution will be unable to meet its debt obligations.
- Loss Given Default, LGD: expressing percentage of exposure which will be not recovered after counterparty's default.
- Exposure at Default, EAD: this term estimating outstanding exposure at the time of default.

3. LGD modelling

Modelling the default risk is an important problem in theory and also in practice of banking and finance. There two basic credit risk pricing models, structural and reduced-form model. These models are based on financial theory, focusing on the financial structure, cash-flow analysis or market prices (Gavláková & Klieštik, 2014).

The structural-form model was first introduced by Black & Sholes (1973) and Merton (1974). Merton model is using the theory of option pricing presented by Black and Scholes. Also know structural model for assessing credit is the Gambler´s ruin model. In the structural model, the credit event is modelled as the hitting time of a barrier by a process adapted to the information flow. The intuition of this model is that the company defaults when the value of its assets is lower that of its liabilities when the debt matures. More specifically, the default of the firm is triggered by the event that the asset value of the firm below a certain threshold level related to the liabilities of the firm.

Moody´s (KMV model) and Morgan model (CreditMetrics TM) are both based on Merton model (Misankova, Kocsova & Adamko, 2014).

Second models and another type of financial models that assume the firms default are called reduced-form or intensity-based credit risk models (Mišanková & Kočišová, 2014). These models was developed by Jarrow & Turnbull (1995) and Madan & Unal (1998). Another best known academic paper focus on reduced-form tests was presented by Duffee (1999), Driessen (2005) and Bakshi, Madan, & Zhang (2006). Houweling & Vorst (2005), Kongstaff, Mithal, & Neis (2005), Chen, Chneg, Fabozzi & Liu (2008) introduced the empirical studies of credit derivatives typically focus on these models. The basic idea of the model is to consider defaults as exogenous events and to model their occurrences using processes and their variants.

4. Reduced-form Models

Reduced-form credit risk models were introduced as a reaction to structural approach, especially trying to decrease informational difficulty when modelling credit risk. In these models default is not conditioned by particular economic parameter of an enterprise (as it is in structural models), but is simply expected to occur at any time with some intensity. By the exogenous default process is modelled this intensity. This approach belongs to the category of market implied approaches (another two are (i) market LGD and (ii) workout LGD). It means that the market prices of defaultable instruments are believed to disclose market expectation of credit parameters under no-arbitrage.

Reduced-form models use market prices of the firms´ defaultable instruments (such as bonds or credit default swaps) to extract both their default probabilities and their credit risk dependencies, relying on the market as the only source of information regarding the firms´ credit risk structure (Valaskova, Gavlakova & Dengov, 2014).

5. Reduced-form approach to pricing CDS

First, I briefly introduce the credit default swap. Credit Default Swaps (CDS) can be defined as a bilateral contract between two counterparties, on of who is buying the guarantee (Buyer) and the other one is selling the guarantee (Seller). Risk is transferred from the buyer to the seller.

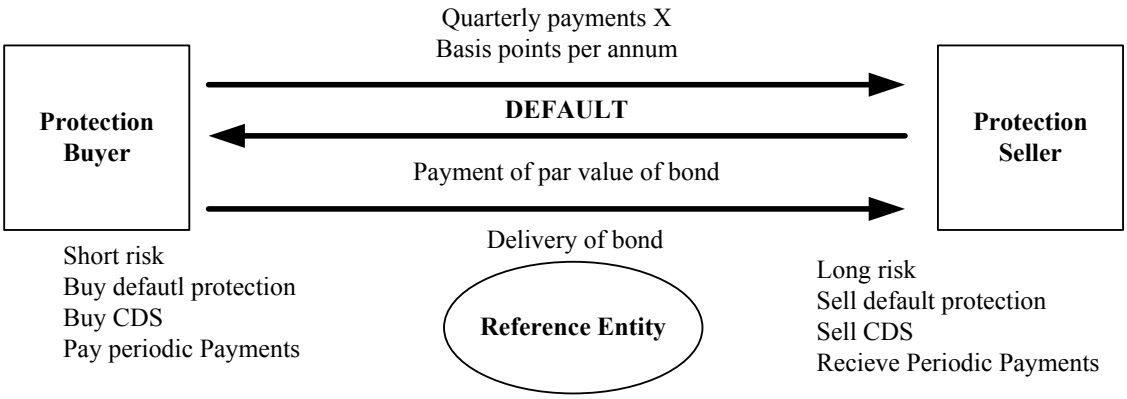

Fig. 1. Credit Default Swap (JPMorgan).

As is shown in Figure 1, Protected Buyer pays to Protected Seller a periodic fee (usually quarterly) for a specific time frame. To calculate this fee on an annualized basis, the two parties multiply the notional amount of the swap by the market price of the credit default swap (the market price of a CDS is also called the spread or fixed rate). CDS market prices are quoted in basis points paid annually, and are a measure of the reference entity´s credit risk (the

higher the spread the greater the credit risk). The seller pays only in case of default and the payment depends on what is agreed in the contract (Kočišová & Mišanková, 2014).

Usually the settlement in case of default is done in one of the three following possibilities, (i) physical settlement, i.e. buyer delivers defaulted bonds with total underlying nominal value equal to notional amount of CDS and is paid the nominal value from seller, (ii) cash settlement, i.e. seller pays the difference between nominal value and the corresponding market price of defaulted bonds of the underlying issuer, (iii) fixed settlement, i.e. fixed amount agreed in contract regardless of after default market price of bonds.

According to the Hull & White (2000), Schlaefer & Ihrig-Homburg (2010) or Doshi (2011) the credit default swap contract follows the basic insurance rule. This rule is that the expected value of premium payments gained by the CDS seller (insurer) must be equal to expected loss that can be incurred by the seller of CDS contract.

In the reduced-form approach, the market value of defaulted bonds is the same as in the fraction recovered from the exposure at default. We use the face value convention, which Hull & White (2000) presented in their model which extended recovery of face value convention for coupon bonds. To calculate the exposure, they added accrued interest since last coupon payment to the face value of bond. Therefore in case of default occurs at time T, than market value of defaulted bonds with notional principle N is (NxR(T)) and amount to be paid within cash settlement is then N x LGD (T). In this case, the timing of the default we don´t know when CDS is issued, value of cash settlement is equal to the present value of losses and then it is possible to occur of future defaults during the life of the CDS contract. It is referred as the protection leg† of CDS contract and the T is the maturity of CDS, then:

$$PV(protection) = \int_0^T LGD(t)xPD(t)e^{-tr_i}\,dt \tag{1}$$

But the probabilities of default and loss given default may be constant during some intervals of time. If life of CDS contract is divided into k interval, than PD and LGD are constant on interval and LGD (ti) denotes percentage of loss incurred when default occurs within interval (ti -1, ti) and PD (ti) denotes the probability of the default in the interval (ti -1, ti). And also the risk free rate ri for interval (ti -1, ti) must be denoted. The adjusted equation (2) is as follow:

$$PV(protection) = \sum_{i=1}^{N} LGD(t_i)xPD(t_i)e^{-t_i r_i} \tag{2}$$

Taking into account possibilities of default at any time up to the CDS maturity and the possibility that no default occurs until the maturity so that all premiums are paid, expected values of the buyer´s fixed premium payments and the s is the CSD spread that the formula is as follow:

$$PV(premiums) = sx\left[\int_0^T PD(t)x\big(i(t)+e(t)\big)\,dt + (1-(PD(T))\,\mathrm{u(T)}\right] \tag{3}$$

The price of credit default swap defined as the annual buyer´s fee, the CDS can be expressed as:

$$s = \frac{\int_0^T LGD(T)xPD(T)e^{-tr_i}\,dt}{\int_0^T PD(t)x(\mathrm{u(t)}+\mathrm{e(t)})\,\mathrm{dt}+(1-\mathrm{PD(T)})\,\mathrm{u(T)}} \tag{4}$$

The premium leg is the series of payments of the default swap spread made to maturity or to the time of the credit event, whichever occurs first. It also includes the payment of premium accrued from the previous premium

† Each credit default swap contract has two legs of payment, the buyer's premium leg and the seller´s protection leg. Assuming no arbitrage, present values of these two legs must be the same, thus present value of protection payment must be equal to the present value of premiums.

payment date until the time of the credit event.

6. Conclusion

Credit Risk techniques have undergone significant development in recent decades. This has led to the development of new methods for the estimation of the potential bankruptcy of borrowing entities and parameters specifying possible losses. These parameters include Loss Given Default, expressing the percentage of an exposure which will not be recovered after a counterparty default. While the estimation of the probability of default has received considerable attention over the past 20 years, LGD has gained greater acceptance only in recent years. Accurate LGD estimation is important for lending, investing or pricing of loan, bonds and credit risky instrument. It is also essential for provisioning reserves for credit losses, determining fair value for any credit risky obligation and calculating risk. The reduced-form modelling is based on the assumption that market prices of defaultable financial instruments disclose the investors' expectations about credit risk parameters. Reduced-form models have proven to be a useful tool for analysing the dynamics of credit spreads.

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