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Determination of Default Probability by Loss Given Default

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Abstract

Determination of credit losses can be provided by banks through the use of an analysis of the actual loan defaults. The quantification of expected losses should be based on an analysis of multiple variables, cause the determination process might be problematic, but it is significant for institutions such as banks but also for others. Main components of the credit risk are the Probability of Default (PD) and the Loss Given Default (LGD). These are included in the credit spread, which is the difference in market prices between defaultable and default-free bonds. The article is dedicated to the theoretical aspects of Loss Given Default.

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1. Introduction

These days measuring of credit risk is considered as a key issue for financial institutions as well as for non – financial companies. Banks are permitted to calculate their own evaluations of the credit risk parameters based on the Basel regulation and under the IRB approach and consequently more precisely align their regulatory capital with the underlying risk in a credit portfolio. There is also another way to manage or handle the credit risk by hedging or trading of the risk.

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There is a numerous growth in the last decades on financial markets with credit derivatives while these derivates are more used for speculation rather than hedging, for which they were mainly designed. These reasons (regulatory as well as speculation on market with derivates) contributed to the formation of new methods for the credit risk estimation. Core components of the credit risk are the Probability of Default (PD) and the Loss Given Default (LGD). These are included in the credit spread, which is the difference in market prices between defaultable and default – free bonds. In the past the attention was paid to modeling and estimating the probability of default while the loss given default was often expected to be constant and exogenously given. This lack of studies on the LGD modeling may be considered mainly due to the fact that the probability of default and the loss given default are difficult to separate based on the price of single financial instrument. (Kollar, Bartosova, 2014)

The article deals with theoretic aspects of Loss Given Default. Credit risk exists in all sectors and companies and this risk has to be calculated and predicted by banks or other financial institution as well as non – financial. So for the calculation of credit risk and especially to predict and calculate losses in case of default of the lender LGD was developed.

2. Credit risk

Financial institutions, banks and also other subjects have been always facing various financial risks. Various financial crisis experienced in the past or recent have shown how important is to predict, estimate and firstly recognize risks properly. Risk management and prediction of potential losses are crucial factor in order to maintain sustainability of business activities of institutions. (Adamko, Kliestik, Birtus, 2014)

Credit risk is just part of financial risk which consists from other types of risks such as economic, financial, technical, political, business or production risk. Financial risk can be defined as the potential financial loss of the company, so not existing or not realized financial loss, but the potential loss in the future resulting from the financial or commodity instrument or from the financial or commodity portfolio. Credit risk than contains the probability of economic losses because of deviations from the credit quality of market members.

In recent years, attitude of banks and other institution to the credit risk has changed. The main tools to moderate credit risk used in the past were collateral and covenants, while nowadays with the development of credit derivatives markets and raise in securitization we can see more opportunities for the banks and institutions in management of credit risk. Second task is that due to the Basel Capital Accord published in 2004 (Basel II), banks were given more edibility concerning the credit risk estimation. While under previous Basel I banks had to use the standardized methodology for calculation of economic capital1, the use of Basel II allows banks to employ their own credit risk models and that leads to better differentiation of risks and to take into account the consequence from diversification of bank's portfolio. (Kollar, Kliestik, 2014)

Techniques used for the estimation of credit risk have changed in recent years, so this has resulted in the expansion of new models for the estimation and evaluation of the likelihood of bankruptcy of individuals or companies and new parameters identifying possible losses. These parameters include *Loss Given Default* and expresses the proportion of an exposure which will not be recovered after defaults of individuals or companies. (Lando, 2004)

3. Loss Given Default

Loss Given Default, is proven in various academic researches, publications or books. The most famous variant of this approach known as LossCals Model is represented and was introduced by Moody´s in 2005. This model is based on the application of multivariate linear regression model which includes certain risk factors, industry and macroeconomic factors, and that includes transformed risk factors. Other famous models were developed by Glossner et al. (2006) and is based on two steps – calibration step and scoring step. The scoring step includes the estimation of a score using collateralizations, haircuts, and expected exposure at default of the loan and recovery rates of the uncollateralized exposure. The score itself can be interpreted as a recovery rate of the total loan but is only used for relative ordering in this case. For computing the distribution of the loss rate depending on the score, this loss rate is approximated by the aggregated exposure of the portfolio up to the score value and the average loss rate of the portfolio.

Another approach by Hamerle et al. (2006) is the estimation model founded on a linear regression in connection with a logic transformation of the LGD and a time consideration by using lag variables within the regression. The dependent variable in the regression is the transformed LGD and the independent variables are credit specific and macroeconomic variables representing potential systematic sources of risk. These systematic risk – variables are reflected with a time – lag. Additionally there are two unsystematic factors included to account for credit – specific risk and also there is a connection amongst credits which is not reflected by the macroeconomics factors.

Peter (2006) and Appasamy et al. (2008) suggest a kind of multi – step method. Both define potential scenarios after default of credit, cure, restricting or liquidation and compute a scenario likelihood – weighted LGD. Either typical scenario LGD or credit specific scenario LGD can be applied. Another potential ways of computing scenario probabilities might be a logistic regression model or applying a Markov chain.

Huang and Oosterlee (2011) made an assumption of a beta distributed LGD and they applied various kinds of beta regressions for modeling LGD. The beta regression are used to evaluation the mean of the underlying distribution depending on certain LGD influencing factors. Additionally, depending on the model, other covariates are expected by linear regression or Maximum Likelihood valuations. It is presented that the beta regressions provide a good way in modeling LGD and finally the portfolio loss distribution could efficiently be approached.

Bastos (2010) showed two models for the estimations of LGD. First method is called fractional response regression and second one is regression tree. The first one is based on log functional relationship or a log functional relationship between the LGD and the independent variables to ensure the bounded nature of the dependent variable. The second one is based on explanatory variables in the way that the group – inhere variance of the LGD is as small as possible.

Based on the distribution of losses the risk – weighted functions produce the capital requirements only for the *Unexpected Losses* **UL** portion, while *Expected Losses* **EL** are considered to stand for ex – ante estimated average losses, therefore being already incorporated into the price of the risky instrument. Normally than Expected Losses can be calculated as the product of PD, LGD and EAD.

Key parameters for the credit risk management are the *Probability of Default* **PD**, which expresses the likelihood of the company to default within the certain period of time; the *Exposure at Default* **EAD**, which represents the amount of outstanding obligations at the time of default and the *Loss Given Default* **LGD**, which expresses the percentage of loss incurred relative to exposure at default **EAD**.

Before definition of the loss given default and its measurement, there is a need to define default. Otherwise there is no compromise about the regular definition. Default can be defined as a disappointment to fulfill a contractual obligation or a required liabilities. (Buc, Kliestik, 2013)

Loss Given Default (LDG) is generally defined as the percentage loss rate exposure if the company happens default event. There is vitally significant to differentiate between **LGD** and *actual loss incurred*, which can be calculated as LGD x EAD. According to Seidler and Jakubik (2009) the total loss consists of:

- the loss of principal,
- the carrying costs of non – performing loans,
- the workout expenses.

Nevertheless the carrying costs and other expenses are minor relatively to the principal loss, therefore it is sensible to assume they will not significantly influence the loss given default rate. Following this assumption, recovery rate, the percentage rate of exposure that lender receive after the obligor defaults can be defined as a complement to LGD as:

$$RR = 1 - LGD \tag{1}$$

LGD depends on many circumstances like the presence of a collateral, the business sector of the debtor, the balance sheet of the debtor and is also dependent on the definition of default. RR is called recovery rate and it is from the interval [0, 1].

Based on equation **RR** can be calculated as one minus LGD, but LGD contents also other costs which are related with the default so it is better to calculate LGD as is shown in equation 2. On the other side these costs are not usually so high so their influence is not so relevant In comparison with recovery rate.

$$LGD = 1 - RR + \cos ts \tag{2}$$

Quantification of LGD is a typical problem in finance. The evaluation of unclear future cash flows. The one difficulty is that the cash flows relate to proceeds expected from post – default resolution or sale of obligor assets, net of recovery costs incurred by the bank, and not the original pre – default predetermined guaranteed payments. If δ is a fixed spread over a risk –free term rate – rt, then the empirical LGD can be defined as (Bielicki, Rutkowski, 2002):

$$LGD = 1 - EAD^{-1} \sum_{t=1}^{T} \frac{C_t}{(1 + r_t + \delta)^t} \tag{3}$$

Where:

EAD	-	exposure of default,
δ	-	fixed risk premium,
Ct	-	net cash flow at time t inclusive of positive flows received under contract from the borrower, or through asset sales, and negative cash flows arising from internal and external costs.

Loss Given Default defined by Moody´s – LossCalc is calculated as the sum of the discounted present values of the intervallic interest shortfalls and principal losses experienced by a defaulted tranche. The rate of the coupon of the tranche is used as the discount rate. Than the equation for calculation of LDGD:

$$LGD_{k,t} = \frac{\sum_{s=k}^{t} \frac{IS_s + LP_S}{(1 + c_S)^{s-k+1}}}{B_k} \tag{4}$$

Where:

LGDk,t	-	denotes the loss severity rate up to time t using time k as the reference date,
IS_s and LP_s	-	denote the net interest shortfall and principal loss at time s, c_s is the discount rate for period *s*,
Bk	-	outstanding principal balance at the reference date *k*.

In these formation are usually three dates of interest: the origination date, the default date and a cohort formation date. Moddy´s (2011)

The estimation of LGD is not so direct, it is determined by many driving factors, such as the seniority of the claim, quality of collateral or state of the economy.

There are two main type of methods for measurement of Loss Given Default. They can be distributed into the ex – post default measurement and the ex – ante default estimation. Based on the classification of Schuermann (2004), there are three generally accepted concepts used for the measurement of the Loss Given Default:

- **Market LGD** – based on the market prices of defaulted bonds or loans,
- **Workout LGD** – based on the estimated cash flows resulting from the workout process,
- **Implied market LGD** – derived from the market prices of non-defaulted bonds or loans.

In the studies there is also mentioned another type of LGD – Accounting LGD. This approach is based on charge – off amounts, so the amount of non – performing facilities. The charge – off amounts are determined by product types, past due days, collateral and by accounting standards which focus on prudence what may not be consistent with risk management policies. (Lehutova, 2011)

3.1. Market Loss Given Default

This type of methodology is measuring of LGD ex – post and is based on the indication that market prices of defaulted bonds or marketable loans imitate the actual expectations of investors about the recovery. The key benefit of this method compared to other ex – post methods is that data can be detected proximately after the default. As well as this market price reflects the total expected present value of the recovery, including recovered principal, missed interest payments and costs associated with the restructuring procedure, all already properly reduced. Actual prices on defaulted bond markets are based on par, thus can be easily transformed into percentage of the recovery. From these we can assume that lot of rating agencies use the **market LGD** for the estimation of recovery. (Valaskova, Gavlakova, Dengov, 2014)

On the other side this method has also disadvantages. The main is that market LGD is not recognizable for some instruments, when there is either illiquid or no market for them. Usually defaulted bank loans are not added transacted so application of the market LGD is restricted. Additional potential market approach is to estimate the recovery rate which is based on the market value of newly issued bonds. This is based on the idea that companies issue the emergence bonds after they reorder and rearrange the initial debt. These bonds are valued by investors showing their anticipation about the value of the company. As new bonds are not issued proximately after the default, price of new bonds must be properly reduced to compute the recovery of defaulted bonds. This market approach is called emergence LGD. (Kliestik, Lyakin, Valaskova, 2014)

3.2. Workout Loss Given Default

Second discused ex – post methodology is based on the process of recovery workout. It reflects bank as an investor who invests into the defaulted asset. It takes into account all cash flows from distressed asset connected to the recovery. The **workout LGD** at default of a single debt instrument than will be calculated as:

$$LGD(\tau) = \frac{EAD(\tau) - PV\left[\sum_{t=\tau}^{T} R(t)\right] + PV\left[\sum_{t=\tau}^{T} C(t)\right]}{EAD(\tau)} \tag{5}$$

Where:

τ	-	default time,
T	-	time when workout process is finished,
PV [C(t)] and PV [R(t)]	-	denote present value of costs and recoveries throughout recovery workout process.

Even though this formulation is mathematically simple in comparison to directly observed market LGD, in fact it is more difficult to determine. Primarily, it is not unambiguous, how these cash flows should be discounted. Not only the timing of cash flows but also the discount rate are needed to be discussed. Banks usually discount at hurdle rate, but the risk-free rate is not exceptional. Furthermore recoveries are often not in form of cash, but in form of securities that might have illiquid or no secondary market. Consequently theirs price is not clear and for banks this would imply that they cannot compute precise workout LGD till all recovered claims are sold which could take a long time. In order not to wait long banks can use their expected value of recovered securities and then calculated Loss Given Default will be also in the form of its expected value. Although there are difficulties the use of workout Loss Given Default measure is considered to exactly reflect the bank's losses. It incorporates specific cost of bank during the workout process and compared to market LGD, it does not include risk premium for unexpected losses. The market LGD is observed directly after the default, not only when the workout process finishes, when adjusted for mentioned differences, it can serve as good estimation of workout LGD. (Ammann, 2002)

3.3. Implied Market Loss Given Default

Different methodology to the LGD estimation is ex – ante **implied market** approach. Equally to market LGD, this method is based on the assumption that the market prices reflect the exact valuation of the security. The implied market LGD estimation, nevertheless does not use the data from defaulted bonds or loans, relatively it studies the

credit spreads of non – defaulted risky bonds over the risk – free bonds (mostly government). This spread is equivalent to the risk premium investor's demand for buying risky bond instead of risk – free bond. The spread is supposed to be expressed by the expectation of investors about the possible anticipated loss. To estimate LGD it is needed to divide the expected loss into PD, EAD and LGD component. (Cisko, Kliestik, 2013)

On the other side Jarrow (2001) claimed that the spread can beside the expected credit loss reflect also the liquidity premium and other risks. This approach is not yet commonly used in banks, but it offers a significant tools for pricing fixed – income securities and credit derivatives. One of the restrictions is the risk – neutral measurement used in the implied market models which is not fully reliable with the physical measure. The implied market models approximating the credit risk parameters can be further separated into structural models and reduced – form models.

4. Conclusion

Methodologies and models for prediction and calculation of Credit Risk have passed important way and development in recent years. So there are various new models and methods used for the estimation and evaluation of probability of default and with it connected parameters used for specification of likelihood of loss as well as potential losses. The article is dedicated to the Loss Given Default as an indicator which expresses the percentage of an exposure which will not be recovered if a company or lender default.

Firstly there where used structural models and reduced – form models while LGD as a part of credit risk has become accepted not only by academic but also by banks and other institutions only in last few years.

Main characteristic which influence and has to be taken into consideration while calculating LGD are seniority of debt, business cycle impact on recoveries and industry impact on recoveries. There are four types of LGD measurement which are based on different assumptions so we distinguish between Market LGD, Workout LGD, Implied Market LGD and some literatures consider also the Accounting LGD. These types of LGD are described in previous parts of article and each of them has its advantages and disadvantages. As we can see credit risk can be found in each type of industry.

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