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Procedia Economics and Finance 23 (2015) 341 – 347

Procedia Economics and Finance

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2nd GLOBAL CONFERENCE on BUSINESS, ECONOMICS, MANAGEMENT and TOURISM, 30-31 October 2014, Prague, Czech Republic

Comparison of Current Credit Risk Models

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Abstract

The aim of this article is comparison of basic characteristics and mutual comparison of three basic current credit risk models. There is significant importance increase of credit risk issue in global economy and also in business sector nowadays. We chose models of renowned companies - KMV, CreditMetrics and CreditRisk+ as appropriate representatives for this article. We focus on differences in computational procedures, individual credit risk modelling techniques, as well as the variability in input parameters, used for risk quantification. Key dimensions that can be used to compare these models are: risk definition, risk sources, data requirements, credit risk event characteristics, credit event volatility, rate of return, numerical design of model and hazard classification. We will use methods of formal logic such as: analysis, synthesis, deduction, comparison. The result will be comprehensive overview of these models differences as well as the presentation of basic recommendations for their usage along with the mention of their advantages and disadvantages. We will also mention test results of various renowned agencies, which reflect the accuracy of these models.

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Keywords: Credit risk; comaprison; dafualt; portfolio;

1. Introduction

We will focus on the overall summary of essential characteristics and mutual comparison of multiple types of current credit risk models in this article. Among them, we chose Moody's KMV, CreditMetrics a CreditRisk+. Each

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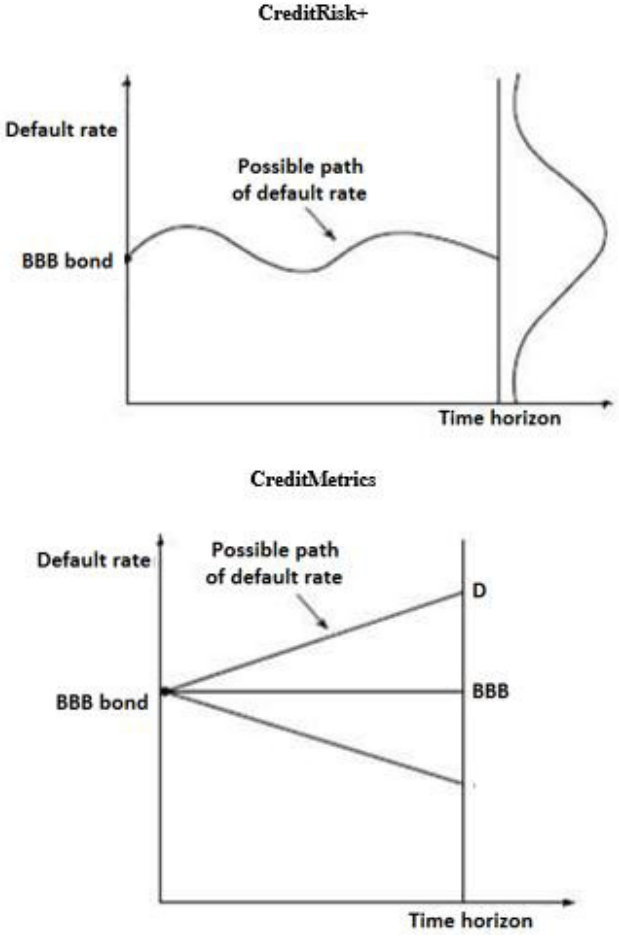
Selection and/ peer-review under responsibility of Academic World Research and Education Center
doi:10.1016/S2212-5671(15)00450-5

of these models uses different critical computing procedures. Individual techniques of credit risk modelling use variety of parameters in the quantification process (Mišanková, Kočišová & Adamko, 2014). We can compare these models with the use of key dimensions like risk definition, risk sources, data requirements, credit event characteristics, credit events volatility, rate of return, numerical design of model and hazard classification (Saunders & Allen, 2002).

2. Comparison of current credit risk models

One of the distinguishing characteristics of each model, in relation to risk definition, is their distribution between two categories. One category is "default-mode" models group and on the other hand there is "mark-to-market" models group (Cisko & Klieštik, 2013). "Default-mode" models focus on predicting losses caused by default, while considering only two possible states: failure and non-failure. This group contains CreditRisk + and Moody's KMV model (there is also the possibility of extending KMV model, which falls into category of multistate "mark-to-market" models). "Mark-to market" models that contain CreditMetrics methodology are focusing on changes in loan's market value and using rating systems to determine changes in borrower's loan quality. The main difference between these two models is introduction of rating migration in the "mark-to-market" models. The "default-mode" models are instead measured solely by the changes in the debtor's assessment, which arise from its failure. Figure 1 shows and compares possible path of default rate for CreditMetrics and CreditRisk + models (Mišanková & Kočišová, 2014b).



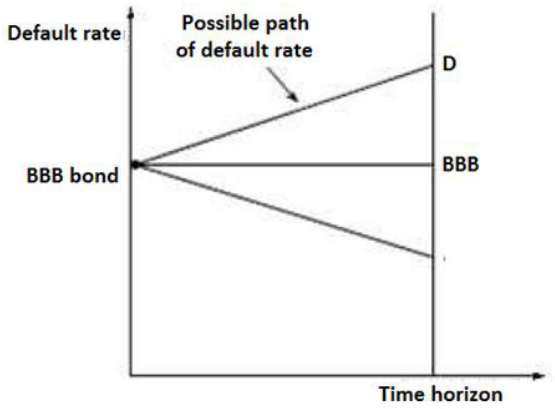


Fig. 1a-b-c. Comparison of CreditRisk1 and CreditMetrics models.

CreditMetrics and KMV models are analytically based on Merton model and therefore corporate assets value and assets volatility are key data sources (Valášková & Klieštik, 2014). In the case of CreditRisk + method, the most important sources are default risk level and its volatility. Credit risk estimation differs across individual models significantly in the form of data management. CreditMetrics input data are historical transition matrices. Key data requirements for KMV model includes time series of assets value, which consists of risk liabilities, risk-free liabilities and stock prices. Assets correlations also influence these models. Tabular mortalities are source for estimation of default rate distribution for each exposed group in CreditRisk + model (Michaliková, Spuchľáková & Cúg, 2014).

Characteristics of a credit event are another dimension by which we can mutually compare these models. Generally, it is possible to describe credit event as the moment when there is a change in the creditworthiness of given bond. Each of examined models, however, specifically defines credit event. KMV method determines credit event as a change in distance to default, which subsequently leads to changes in the EDF value (Kočišová & Mišanková, 2014). CreditMetrics model characterizes credit event as a state, when there is rating migration. Empirical analyses, however, suggest that EDF value reacts to changes in the credit quality of borrower slightly faster than the change in rating classification. Therefore, credit event occurs more frequently in the case of KMV model than in CreditMetrics model. Within the CreditRisk+ method, we determine credit event by the default state, as it is unique "default-mode" model type. At the same time, however, changes in the default rate may signal decrease in the credit quality of borrower.

There are also differences between various current credit risk models in default probability modelling within one year or distribution function of default probability. Volatility of credit event is within the CreditMetrics model stated by default probability, which is modelled on the base of historical data (Buc & Klieštik, 2013). Expected frequency of failure value changes in response to changes in market value and volatility of assets in the KMV model. CreditRisk+ models default probability represented by Poisson distribution (Gavlaková & Klieštik, 2014).

Recovery rate is considered to be exogenous constant parameter for each sub-portfolio of loans in CreditRisk+ model. CreditMetrics includes variant of recovery rate estimation as a random variable with beta distribution and is modelled with the use of Monte Carlo simulation (Spuchľáková & Cúg, 2014). A simple version of KMV model considers return rates to be constant parameters, while in extended KMV model version, these rates follow beta distribution. We can also find some differences in the numerical approach of model for estimation of unexpected loss or value -at-risk. While KMV model admits analytical solutions just like CreditRisk+ model, these solutions are usable only for few instruments in the case of CreditMetrics. With increasing number of instruments in portfolio, model uses Monte Carlo simulation technique, which allows us to generate approximate distribution of portfolio's value. Table 1 provides a comparison of individual key dimensions across models CreditRisk+, CreditMetrics and KMV.

Table 1. Comparison of current credit risk measurement models. (Saunders & Allen, 2012)

	CreditMetrics	CreditRisk+	Moody´s KMV
Who developed model	JP Morgan	Credit Suisse	KMV
Risk definition	Market value of assets	Losses from default state	Losses from default stare
Risk source	Assets value at market value	Default probability and default rates	Value of assets
Data requirements	Historical transitions matrix, credit spreads, correlations, LGD	Default rates and volatility, macro factors, LGD	Value of assets, credit spreads, correlations
Characteristic of credit event	Credit migration	Random default rate	Distance from default
Volatility of credit events	Constant	Variable	Variable
Recovery rates	Random (beta distribution)	Constant	Constant or random
Numerical approach of model	Simulation or analytic	Analytic	Analytic
Risk classification	Ratings	Exposure bands	Empirical EDF

3. Analysis overview

The International Swaps and Derivatives Association (ISDA), along with The Institute of International Finance (IFF) published study in 2000 that tests credit risk measurement across multiple current models on a sample of 25 commercial banks in ten countries. KMV, CreditMetrics and CreditRisk+ are among the models examined in the study (Saunders & Allen, 2002). The results of this research indicate that the models gave similar results, unless they have been given similar inputs. Any discrepancies between the models are therefore due to unequal inputs and pre-processing (i.e. formatting transactions into a readable form), valuation, errors in the use of model during testing and misunderstandings regarding the use of standardized parameters (Gregová, 2007). Substantial differences in the results across the different models can be attributed to different valuation approaches. Model outputs are therefore strongly influenced by valuation methods, changes in spreads or discount rates. The most important risk sources of portfolio are credit quality (tested by subjecting the portfolios to some downgrade scenarios), loss in the case of default and asset correlation (Klieštik, Lyakin & Valášková, 2014).

Another comparative study was published by Koyluoglu, Bangia and Garside in 1999 (Koyluoglu, Bangia & Garside, 1999). They focused mainly on the impact of parameters inconsistency, while comparing modelling techniques of credit risk portfolio: KMV, CreditRisk + and CreditMetrics. Structurally, the models do not differ significantly from each other, but each of these models use different parameters to quantify the joint insolvency of obligors, while the common default in KMV and CreditMetrics models is determined from assets correlation between individual companies and volatility default rate is used to establish common default in CreditRisk+ model (Mišanková & Kočišová, 2014a). Default probability of each obligor is estimated by using various techniques across different models, whether it is an estimate based on Merton model or estimate based on historical default rates (Boďa, 2014).

The results of this study indicate the existence of significant irregularities in estimates of expected loss, unexpected loss and value at risk resulting from the inconsistency of input parameters. Potential sources of inconsistency are caused by unequal numerical system calibration of default probability, i.e. assigning EDF and assigning parameters of common default and the sophistication level of parameters specification, along with the rate of return, exposure and asset correlation (Klieštik & Birtus, 2013). The quality of estimates made by different modelling techniques is compared between different sub-portfolios. Minor inconsistencies across these models, can be found in segments of the portfolio rather than in entire portfolio (Buc, Križanová & Klieštik, 2013). In other words, we can say that smaller differences in estimates appear, when we evaluate homogeneous sub-portfolios (portfolios with high or low creditworthiness) separately (Adamko, Klieštik & Birtus, 2014).

In general, bigger differences occur between models oriented on credit risk estimation for low creditworthiness portfolio of bonds than between models for higher creditworthiness portfolio. Assets correlation differences between KMV and CreditMetrics models are smaller in the case of high creditworthiness portfolio (Cisko, 2013).

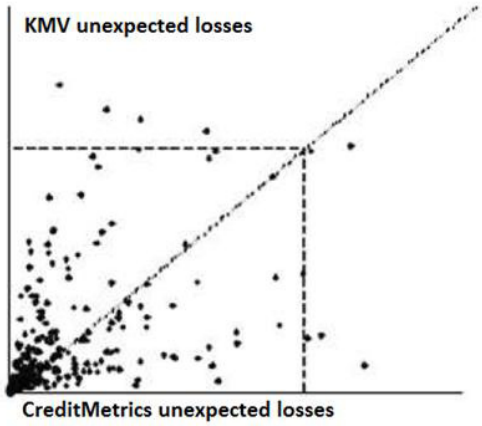


Fig. 2. Unexpected losses comparison of CreditMetrics and KMV models for entire portfolio. (Koyluoglu, Bangia & Garside, 1999)

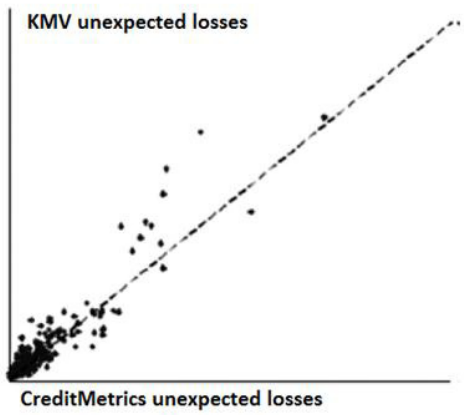


Fig. 3. Unexpected losses comparison of CreditMetrics and KMV models for portfolio with high creditworthiness. (Koyluoglu, Bangia & Garside, 1999)

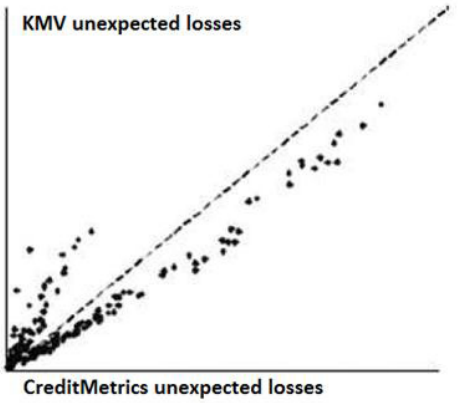


Fig. 4. Unexpected losses comparison of CreditMetrics and KMV models for portfolio with low creditworthiness. (Koyluoglu, Bangia & Garside, 1999)

Figure 2 shows comparison of CreditMetrics and KMV models based on estimations of unexpected losses across the entire portfolio. Differences between models in estimations of unexpected losses in portfolio allocation for high- and low-grade subsequently shows figure 3 and figure 4.

4. Conclusion

According to us the biggest disadvantage of CreditRisk+ model comes from Poisson distribution, because it underestimates the probability of default for all rating grades. On the contrary main advantage comes from easier way of calculation. CreditMetrics is characterized by great flexibility when applied to different types of assets, as well as being really comprehensive, because the assumptions used by it are not too restrictive. On the other hand, due to the relatively slow convergence, it is time-consuming and also computationally intensive. KMV model is the easiest to apply to publicly traded companies for which the value of assets is determined by the stock market. Critical points of this model are market value and volatility of capital.

Acknowledgements

The contribution is an output of the science project VEGA 1/0656/14- Research of Possibilities of Credit Default Models Application in Conditions of the SR as a Tool for Objective Quantification of Businesses Credit Risks.

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