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CREDIT RISK MANAGEMENT IN FINANCE.
A REVIEW OF VARIOUS APPROACHES

Classification of customers of banks and financial institutions is an important task in today's business world. Reducing the number of loans granted to companies of questionable credibility can positively influence banks' performance. The appropriate measurement of potential bankruptcy or probability of default is another step in credit risk management. Among the most commonly used methods, we can enumerate discriminant analysis models, scoring methods, decision trees, logit and probit regression, neural networks, probability of default models, standard models, reduced models, etc. This paper investigates the use of various methods used in the initial step of credit risk management and corresponding decision process. Their potential advantages and drawbacks from the point of view of the principles for the management of credit risk are presented. A comparison of their usability and accuracy is also made.

Keywords: *credit risk, default, bankruptcy, credit risk management, credit risk models*

1. Introduction

The prediction of bankruptcy has been an important and widely studied topic in finance because it has a significant impact on the whole economy – the lending parties, chain of suppliers, stakeholders, etc. Managing credit risk is a complex multidimensional problem. Credit risk can be perceived as a major threat that banks face. There are a number of different approaches that are used in credit risk management. Depending on the amount that can be lost in the process of lending, the following must be taken into consideration:

• probability of default (PD) when the amount lost is the same in each case (in the case of a set of companies),

• PD and expected loss (EL) given default (in the case of an individual company).

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The fundamental importance of credit decisions was especially highlighted by the crisis of 2007–2008 which started with sub-prime mortgages in the US.

Any decision in the process of managing credit risk involves a lot of stages, which may be of various levels of objectivity. This requires experience and an analytic approach combined with correct judgement and appropriate evaluative techniques. The main purpose of this paper is to review these techniques, their basis and origin, the changes implemented and improvements.

2. Risk – overview

Generally risk accompanies any action in life. It involves the potential of gaining or, in particular, losing something of value. There are many different classifications of the phenomenon of risk. Basic types of risks can be political, legal, technical, environmental, economic, etc. The latter is usually associated with the influence of financial and other economic factors on a project. Economic risk can also be described as the chance that macroeconomic conditions, such as exchange rates, government regulation, or political stability will affect an investment.
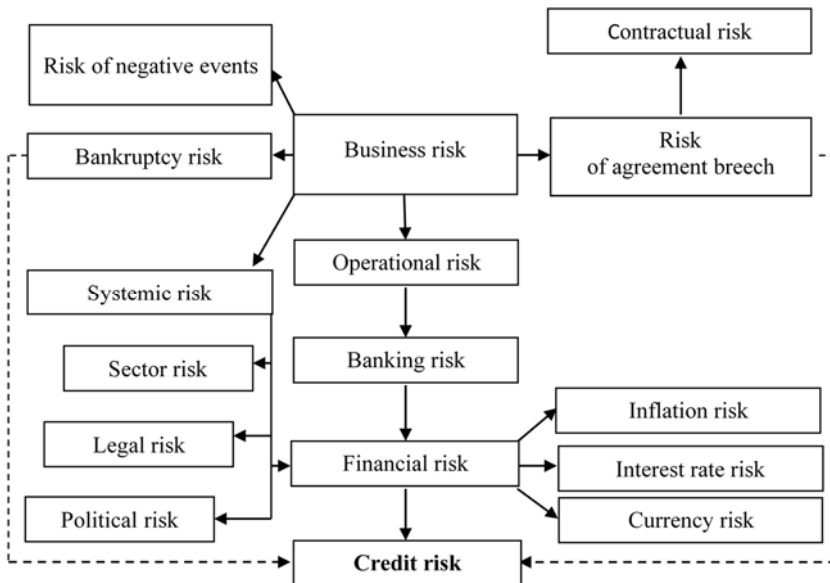

Fig. 1. Kinds of business risk. Based on [12, 15, 21]

In a market economy, risk is especially visible in aspects of running a business. It starts with the risk associated with starting a company, then actual operations within the

company's scope of activity and taking decisions, which can have a positive or negative effect – with a certain level of probability or in conditions of uncertainty. This is often called business risk. Business risk can be defined as the possibility that a company will have lower than anticipated profits or experience a loss rather than making a profit. Another definition says that business risk impairs a company's ability to provide its investors and stakeholders with adequate returns. Within the concept of business risk, a company is also exposed to financial risk, liquidity risk, systematic risk, exchange-rate risk and country-specific risk, etc. Diagram 1 presents one of the approaches to categorising business risk. However, it must be highlighted that the risks presented are not disjoint and very often they are closely linked with each other or appear together.

3. Credit risk

Credit risk originates from financial risk which is a constituent element of banking risk. There are many various definitions of credit risk. However, they always have some element in common. One such element is the fact that a counterparty (borrower) might not repay the financial means that were lent to them. In the literature we can find the following, chosen definitions of credit risk, which can be defined as the "possibility of loss arising from the failure of a counterparty to make a contractual payment" [11]. It is also broadly conceived as the probability of the non-repayment of financial resources granted by a bank to debtors[9] or the risk of default on a debt that may arise from a borrower failing to make the required payments [13]. However, it should also be noted that credit risk is not only related to potential financial loss but it also threatens deterioration of the borrower's credit rating and performance.

Credit risk is susceptible to all subkinds of financial risk such as the risk of interest rate change, risk of changes in the national economy, but also to specific kinds of credit risk solely, such as: collateral risk, default risk and concentration risk. Credit risk also fits into the categories of counterparty risk and settlement risk. It also very often interacts with currency exchange risk and liquidity risk. Therefore, reliable estimation of the level of credit risk and the appropriate credit rating that follows this, reduces the threat of bankruptcy, not only of a particular company, but also of all cooperating companies and financial institutions. The increasing number of bankruptcy announcements means that even greater attention is being paid to appropriate evaluation of the probability of default (PD).

4. Credit risk management

According to *Principles for the Management of Credit Risk BCBS September 2000* [23], the major reason leading to banking problems is related to lax credit standards for borrowers and counterparties. This is expressed, inter alia, in:

- poor portfolio risk management,
- a lack of attention to changes in the economic world,
- a lack of attention to deterioration in the credit standing of a bank's counterparties.

One must remember that loans are the largest and most common source of credit risk and, as mentioned above, banks are increasingly facing credit risk in various financial instruments. Therefore, an increased awareness of the need to identify, measure, monitor and control credit risk is necessary, as well as determining the appropriate level of capital to protect against credit risk.

In banking, the ability to manage the credit risk process is vital and covers the following stages:

- identification of risk – rating,
- risk evaluation – costing,
- pricing,
- monitoring,
- adaptation/implementation.

The latter three elements fit into the category of risk control. The first two (identification of risk and risk evaluation) are elements which require appropriately established methods and use models to improve the final outcome of all the processes of credit risk management.

Each bank implements their own policy of credit risk management, as this represents a competitive advantage of the bank. The techniques used in this process can be different and can include:

- more stringent requirements for measuring exposure,
- higher levels of capital for inter-financial sector exposure,
- reducing the number of loans granted to companies of questionable credibility,
- reducing the number of rejected loans for companies of high credibility.

Such a policy includes different approaches to a single loan or a portfolio of loans. Credit risk management for a single loan will include: analysis of the entity's solvency, establishment of loan limits, loan collateral, monitoring and controlling solvency after granting finance. In the case of a portfolio of loans, the following elements can be enumerated: risk diversification, collateral, risk transfer, organisational and HR actions.

5. Models and methods – various approaches

The financial crisis has led to a tightening up of the conditions for gaining finance from banks. The methods adopted vary from judgemental methods and expert systems, through analytic, statistical and behavioural models to market models. In judgmental models, the assessor's experience and understanding of a case is applied to making the

decision of whether to grant or refuse credit. Expert systems, in turn, use a panel approach to judge a case or formalize judgmental decisions via a lending system and procedures. Analytic and statistical models use quantitative, analytic and statistical relationships to come to a decision. Behavioural models derive appropriate relationships to reach a final decision based on observed behaviour over time and market models rely on information from financial markets.

Another approach to models of credit risk divides them into classical and modern approaches. In the first group, we can enumerate discriminant analysis models, scoring methods, decision trees, logit and probit regression, etc. Classical models are based mostly on the input of financial analysis and the opinion of experts.

The origin of probability of default models is in the Merton model, which is based on the Black–Scholes model of an option. Other structural and reduced models are adaptations of that model and even some of the latest models originate directly or indirectly from Merton. Among probability of default models, we can enumerate the models introduced by: Geske, Hull, Nelken and White, Black and Cox or the non-parametric Chen, Hu, Pan model. A comparison of chosen structural models is presented in Table 1.

Table 1. Comparison of chosen structural models

Model	Theoretical bases	Assets evaluation (A)	Characteristic features
Merton	Black–Scholes	European call option on a company's assets at the expiration date T and strike price D	a company is bankrupt if at time T the value of the assets A is below the default level of assets ($-_{def}$)
Geske	Black–Scholes, Merton	combined option (option comprising a European call option)	estimation of various kinds of PD (*short-term, forward and at time* T)
Hull, Nelken, White	Geske		assessment of the relationship between the implicit variability of an option and moneyness[a] (profit/loss from exercising an option)
Black–Cox	Black–Scholes, Merton	European call option on a company's assets at the expiration time T and strike price D	the company is insolvent from the moment when its level of assets A falls below the level A_{def}
Non-parametric	Merton		insolvency leads to bankruptcy

[a]In finance, moneyness is the relative position of the current price (or future price) of an underlying asset (e.g., a stock) with respect to the strike price of a derivative, most commonly a call option or a put option.
Source: based on [16–20].

A lot of research has been done on various models of credit risk (default models using a modern approach) that can be classified into different groups, e.g., structural models [2, 10, 22] or reduced form [7], and numerous modifications [3, 5, 6]). There is

also research on particular elements of these models and empirical results from their implementation, e.g., return rates or credit spreads [1, 8].

Authors of reduced models often criticise the assumptions of structural models, e.g., that an investor possesses full information at every moment on the real value of a company's assets and the default threshold. Therefore, it can be assumed that structural models with non-full information are equivalent to the corresponding reduced form of structural models with an endogenous intensity of default. A comparison of the most commonly used reduced models is presented in Table 2.

Table 2. A comparison of the most commonly used reduced models

model	Moment of default (T)	Recovery rate (RR)	Interdependencies
Jarrow–Turnbull (1995)	constant intensity	constant	T and RR are not interdependent
Madan–Űnal (1998)	intensity depends on stock prices	stochastic	
Lando (1998)	intensity depends on economy	dependent	interdependencies are acceptable
Duffie–Singleton (1999)			

Source: [23].

There is a large group of models which were and still are actively used in practice. They are based either on Merton's approach or VaR (value at risk). Among these, we can list, e.g.: MKMV (Moody, Kealhofer, McQuown, Vasicek), CreditMetrics, Credit -Risk+[2], and modifications such as Byström or Benos and Papanastasopoulos (a hybrid model).

Unfortunately, the implementation of some of those models (MKMV, Byström, etc.) is impaired in the case of the Polish economy, due to the limited amount of data available regarding the market value of assets [18–20].

6. Conclusions

Credit risk is one of the most significant risks which banks are exposed to. It can be followed by many negative effects, which are experienced not only by a bank itself, but also by other participants of the financial market. There are many tools which can be used to prevent or manage and monitor credit risk. Failing to detect or ignoring signals of economic deterioration or of a decline in a borrower's financial condition cannot be justified. Among these tools we can list: scoring methods, discriminant analysis, decision trees, regression functions, neural networks, default models, standard and reduced

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[2]To find out more about MKMV, CreditMetrics or CreditRisk+ see, e.g., [16–20].

models, VaR models and models which form the so-called new approach. However, as the review has indicated, the improvements, evolution and all the progress made in credit risk modelling originate from models formulated dozens of years ago. All of the most recent models are based on Merton (1974) and however ground-breaking and innovative the improvements may seem, they are largely grounded in ideas formulated decades ago. Therefore, it can be stated that, irrespective of the actual time of creation, no revolutionary ideas have been created.

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