Models to Assess the Bankruptcy Risk

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ABSTRACT

Closely related to financial risk assessment, one of the main concerns of the organizations should be the evaluation of bankruptcy risk, in this period of slow economic growth. Organization bankruptcies have increased in recent years worldwide. The aim of this paper is to demonstrate that the methods and models for forecasting bankruptcy of organizations, for the bankruptcy risk assessment are seeing for the health financing of an entity in financial accounting diagnosis and that the organizations requires assessment of risks accompanying the work, in which some signals fragility (vulnerable health) this and other projected bankruptcy (insolvability) threatens its survival (continuity). The bankruptcy risk assessment is important for profit-seeking investors because they must know how to value a company in or near bankruptcy is an important skill, but to detect any signs of looming bankruptcy is necessary to calculate and to analyse all kinds of financial ratios: working capital, profitability, debt levels and liquidity.

1. Introduction

Risk assessment is fundamental in the economic activities as it provide the appropriate policies and selects effective techniques to combat risk and, since risks and threats change over time, it is necessary for organizations to periodically reassess risks and reconsider whether the policies, decisions and control chosen are appropriate and effective. After identifying risks, this stage of evaluation, measurement and analysis is one of the most important since the discovery of risk, which depends both on the nature of the impact and the probability of its application, leads to the next stage of risk management arrangements in the most effective way.

There are numerous and different methods and models for assessing risk impacts, determination of the magnitude of the impact of these dangerous situations on economic activity and the progress of the analysis and resources spent can vary the extent to which they have reproducible data on factors risk. In most of the literature is found the statement that once it is determined the probability of risk, one can proceed to measure it based on several numerical value known as the average dispersion, standard percentage deviation, coefficient of variation.

Methods of calculation of these quantities are unambiguous [1]. But if risk factors are independent then in the relationship will interfere calculating risk probabilities of occurrence, and if risk factors are dependent, then the conditional probabilities occur, which significantly complicates the calculations in determining the overall risk to the organization concerned.

The bankruptcy risk occurs when an organization is unable to honour due obligations resulting in insolvency (the condition of the heritage of the debtor organization characterized by lack of funds to pay the required debts). The causes of this situation are due to both internal and external factors. From some statistical studies it was found that the degree of economic and social environment causes in triggering the bankruptcy risk is about 51%.

Some signs of triggering bankruptcy of a financial nature could be: imbalances of permanent supply and use; disruption in time of existence of an unsatisfactory working capital, which makes it necessary to ask for current loans to finance investments; unable due repayment of these loans and renewal impossibility; problems of customers and suppliers management, poor inventory management, high debts to the state budget or to employees, permanent tendency to reduce activity and operating losses [2], market instability, inefficiency of horizontal (administrative, legal) institutions and vocational training systems, lack of financial resources, etc.

Because the organizations bankruptcy is not only due to internal and external causes, it has repercussions (the domino effect) to the partners (and the whole economic system) that took part in the economic activity supported by the organization, these being as mentioned above: customers, suppliers, public (national and local) institutions.
The need to assess these risks means to alert administrators, managers of organizations to take action to save the business or to limit losses and at the same time to inform potential investors about the state of affairs of an organization before deciding investments.

The methods and models for forecasting bankruptcy of organizations, i.e. for the bankruptcy risk assessment at their inception (beginning of the century) as insolvency prediction models did not have the expected effect on the economic environment, due to difficult way of determining it. Their calculation meant a laborious arithmetic effort, difficult to interpret for non-specialists. With time due to the evolution of the IT environment and the evolution of these methods, the uses of these prediction methods are becoming more accessible to those interested. Gheorghe Negoescu believes that the risk of bankruptcy is inevitable related to profit variability as determined to an average profitability of an earlier period, or to the variation of the turnover [3].

Some of the most circulated methods and models in the literature are:
- the method of balance indicators: the working capital, working capital requirements and treasury
- rate method
- scoring method
- risk assessment models for bankruptcy statistical methods: The Altman model, Conan and Holder models, the model of French bank balances
- risk analysis models for bankruptcy banking methods
- method of decision tree, logistic regression, methods of neurons networks and expert systems.

2. The method of balance indicators

The risk of failure can be evidenced by the financial equilibrium equations for bi-univocal correspondence between the liquidity of assets and liabilities chargeability [4].

For the financial risk analysis based on balance indicators method use is made of: the working capital, working capital requirements and treasury. Briefly, these factors are as follows:

- **Working capital**
  - comes from comparing the structure of active asset liquidity and the passive eligible structure and is the security reserves of the organization. It is solvent if: permanent capital = current assets (Own + Borrowed) and if Current assets= Current liabilities. In reality it is very difficult to reach this situation because debts are clear, and the transformation of active assets into asset availability is random.
  - The working capital is a means of financing and also an indicator of liquidity. The higher the more it can cover short-term debt to finance current assets. The disadvantage of this method is that it does not take into account numerous financial and economic characteristics of the firm. Working capital can be calculated:
    \[ FR = \text{Permanent capital assets} - \text{net assets} \]
    \[ FR = \text{Current assets} - \text{total short-term debt} \]
    When working capital is negative there is the possibility of difficulties in terms of financial stability, so cash does not cover outstanding liabilities.
    - Working capital need
      - **Net treasury**: \( TN = \text{Working capital} - \text{working capital required} \)
      - Short-term risk of default of the obligations resulting from the mapping of liquidity of assets with liabilities chargeability. The following situations can occur [5]:
        1. \( AC = DTS \) (liabilities) \( FR = 0 \) \( \Rightarrow \) even if the organization is able to pay its short-term obligations, this balance is fragile and can be undermined by any disturbance in the recovery of loans
        2. \( AC > DTS \) \( \Rightarrow \) \( FR > 0 \) \( \Rightarrow \) there is a surplus of cash, the organization is in a favorable situation which allows to cope with the due dead line
        3. \( AC < DTS \) \( \Rightarrow \) \( FR < 0 \) \( \Rightarrow \) liquidity does not cover chargeability and organization has difficulties in terms of financial stability [6].

3. Rates method

This method allows comparative studies across time and space, objective assessment of the position and performance of various organizations. In economic theory there are 150 financial rates/ratios, but in practice only a part is used in the risk assessment. Risk analysis should note take into account only one rate
as it would not be significant. The rates used in assessing default risk involving organization liquidity and solvency research are:

**a. Liquidity ratios.** To analyse the liquidity of organization, this actually aims its ability to pay its current obligations from current sources. This category includes:

- General liquidity ratio – it’s a measure of the organization capacity to honour its obligations in the short term (exploitation) from the operating assets.

\[
RLG = \frac{\text{Current assets}}{\text{Passive assets}}
\]

Where:

- **Current assets** = inventories + receivables + short term financial investments + cash;
- **Passive assets** = liabilities due in the short term.

Most times it is considered that the overall liquidity reflects a better position if its values range between [1.2 to 2] the minimum limit being 1.

- Reduced liquidity ratio – it’s a measure of its capacity to honour short-term debts of those assets that can be converted relatively quickly into cash. Thus, for calculating the rate, the influence of the stock liquidity is eliminated. As a means of calculation, reduced liquidity ratio can be determined:
  - by decreasing the value of inventories from the value of current assets and reporting the value of current liabilities;
  - by reporting the amount receivable, short-term financial investments and cash, to the value of current liabilities.

The optimal size of this indicator is 1, but this rate is usually nil, considering that a level between [0.6 to 1] reflects a good capacity to pay short-term obligations. Overcoming the optimal level may reflect either inefficient use of claims (their collection is difficult) or the availability (lack of strategy in using them). It is estimated that this rate should have values close to 0.8.

- Immediate cash rate - assess the extent to which debts can be covered by cash available, maps the most liquid elements to short-term debt as follows:

\[
RLI = \frac{\text{Availability's}}{\text{Immediate debt due}}
\]

The optimum value of this liquidity rate is between [0.2 and 0.3]. A higher value of this ratio is not a guarantee that the organization can pay short-term debts if the other elements of circulating assets have low liquidity.

- Current liquidity ratio - put in correspondence the most liquid asset items with short-term obligations, reflecting the organization’s ability to meet short-term obligations and cash investments, given by:

\[
RLC = \frac{\text{Short-term financial investments + Cash}}{\text{Short term debts}}
\]

The optimal value of this rate lies between [0.4 and 0.6].

- Sight liquidity ratio - appreciate the extent to which short-term bank loans can be covered at the expense of cash in cashier and bank accounts, calculated as

\[
RLV = \frac{\text{Cash in cashier and bank accounts}}{\text{Short-term bank loans}}
\]

The optimal value of this rate lies between [0.85 and 1.15].

**b. Solvency ratios.** Solvency can be defined in two ways [6]:

- As an organization’s ability to meet its commitments in the event of liquidation;
- As an organization’s ability to pay long-term obligations.

Based on these definitions, we can analyse solvency from: overall or general solvency, partial solvency and immediate solvency.

General or global solvency ratio indicates the extent to which the organization’s total assets may cover total debt. Minimum allowable value is 0.5 and is given by the formula:

\[
RSG = \frac{\text{Joint stock}}{\text{Total debts}}
\]

When the rate is:

- over-unit - current assets are higher than short-term debt, therefore the organization uses a part of the permanent capital to finance the operation;
- negative - means that working capital is negative, short-term debt cannot be covered by current assets
Partial solvency ratio - reflects the organization’s ability to cover short-term debts from receivables and cash. Optimal situation is when it lies between [0.8-1].

Immediate solvency ratio - reflects the organization’s ability to cover outstanding liabilities immediately, using most liquid asset elements. The ratio must have a value greater than 0.3, but is not a guarantee of solvency if other current assets have low liquidity.

The rotation rates (activity) - highlight and measure the effectiveness of the organization in using its available assets, called rates on asset management. This type of rate measures the efficiency of the organization in using assets, especially those linking different elements of current assets to turnover.

The leverage ratio - also called rates on debt management, explains the degree of organization financing from external sources and points out to the capital structure used in financing the activities. They are influenced by the allocation of capital and optimizing the business risk, the decisions of investment or the current needs of business funding (when the economic and financial situation is weaker) or payment of debts.

The rates of return – combine the effects of liquidity, the asset rotation and level of indebtedness. This is demonstrated by Du Pont system [2].

4. The scoring method
Because default risk is the most important stage an analyst must take into account in making future estimates, researchers and international financial institutions in 1960 the U.S. have developed a prediction methodology, a method called scoring method, an improved evaluation methods by instalments.

The method is based on statistical techniques of discriminant analysis of financial characteristics, determined by rates. Application involves taking some steps: identification of at least two distinct groups of organizations: one with financial difficulties and one with very good financial results, establishing for the two groups a series of rates that allow comparison and best separation of the two communities and obtain for each organization, by applying discriminant analysis, a ranking indicator called "Z" score by a binary function of the type:

\[ Z = a_1 x_1 + a_2 x_2 + \ldots + a_n x_n \]

Where:
- \(x_n\) – values taken by the chosen ratios
- \(a_n\) – numerical coefficient, the weighting of these rates. This indicator provides a good approximation of the bankruptcy risk, concluding in classifying organizations as "healthy" or in need.

The process is known in economic literature as multiple discriminant analysis method (MDA). In synthetic terms, the multiple discriminant analysis is a statistical technique used to classify an observation apriori into two or more groups according to observable individual characteristics.

In global economic literature, based on scoring method the following models are often used: The Altman model called "Z" model Canon and Holder, The French bank balances plan. An.

5. Models for bankruptcy risk assessment by statistical methods
The Altman mode - developed in 1986 by Edward I. Altman, the oldest of all developments of bankruptcy prediction models, makes use of the statistical study of 33 companies with financial problems selected by type and activity and of 33 problem-free companies selected by the principle of similarity for a period of 20 years. Out of the 22 reports only 5 were selected being considered the most representative for an organization. The proposed score function or mathematical representation of the model is as follow:

\[ Z = 1.2 X_1 + 1.4 X_2 + 3.3 X_3 + 0.6 X_4 + 0.999 X_5 \]

Where:
- \(X_1\) - reflects the flexibility of the organization and is determined as the ratio of working capital (operating assets - operating current liabilities) or working capital and total assets
- \(X_2\) –is the self-financing rate of total assets and is determined as the ratio of profits reinvested (net result of the year - dividends given to shareholders) and total assets
- \(X_3\) – is the economic rate of return calculated as the ratio of gross result of the exercise and total assets
- \(X_4\) -highlights the debt ability of the organization and is calculated as the ratio of market capitalization (for unlisted firms is used the capital) and medium and long-term debt
- \(X_5\) - measure the return on assets and is calculated as the ratio between turnover and total assets.

From the information provide by the indicators is is found that their values are even better as the absolute value is higher. Therefore hierarchy of organizations depending on the variable \(Z\) is as follows:
- If \(Z > 3\) the organisation is solvable;
- If \(Z \in [1.8,3)\) the organisation has financial difficulties but it can recover its work by adopting a proper strategy;
- If \(Z < 1.8\) the organisation when bankruptcy is imminent.
The 1968 model was able to predict the success or failure of an organization two, three years before its occurrence, and the model developed in 1977 makes a prediction of five years before the event. In spite of all the benefits that brings, this method has several drawbacks including:

− Use of "historical" information;
− Different accounting of heritage movement
− "creative" accounting
− obsolete accounting estimates.

Professor Altman’s model is applied with good results to companies listed on stock exchange.

The Conan & Holder model. Developed in 1978, it applies to a number of industrial enterprises with 10 to 500 employees and is based on the analysis of "liquidity - chargeability". In 1978 by observation of a number of 31 ratios/instalments on a sample of 190 small and medium enterprises, half of which went to bankrupt during the period 1970-1975. The model has 5 variables and is also based on function “Z”, having the following [7]:

\[ Z = 0.24 X_1 + 0.22 X_2 + 0.16 X_3 + 0.87 X_4 + 0.10 X_5 \]

Where:

X1 - gross operating surplus / total debt, the indicator shows the own capacity of debt financing
X2 – permanent capital / total assets, it measures patrimonial solvency
X3 – Current assets (without stocks) / total assets, it measures the performance of the assets
X4 – financial expenses / turnover, reflecting the financial costs
X5 – staff expenses / Added value it reflects the degree of staff remuneration

When score framing is:

− \( Z > 0.16 \) ⇒ organisation situation is very good/bankruptcy risk is lower than 10%
− \( 0.1 < Z < 0.16 \) ⇒ organisation situation is good / bankruptcy risk lies between 10% - 30%
− \( 0.04 < Z < 0.1 \) ⇒ organisation is under alert/ bankruptcy risk lies between 30% la 65%
− \( -0.05 < Z < 0.04 \) ⇒ organisation is in danger/ bankruptcy risk lies between 65% la 90%
− \( Z < -0.05 \) ⇒ organisation has failed / bankruptcy risk is higher than 90% [8].

It is therefore apparent that the smaller the value of Z, the more vulnerable the organization. Among the disadvantages of this model there are observed:

− Use is made only of indicators of financial condition which cover only part of the capital remuneration.
− Financial stability can be achieved through a high degree of indebtedness of the organization
− Interim liquidity can be achieved by increasing trade credit to customers [9].

France Central Bank’s balance sheet model predicts the risk of bankruptcy for French organizations by a score of 8 variables, for the selection of which it was developed a sample of 3,000 industrial facilities (ranked in healthy organizations and others with weak activity) with less than 500 employees, studied for 3 years between 1977-1979. Score function is as follows:

\[ Z = 1.255 X_1 + 2.003 X_2 - 0.824 X_3 + 5.221 X_4 - 0.689 X_5 - 1.164 X_6 + 0.706 X_7 + 1.408 X_8 - 85.554 \]

Where:

X1 - sampling rate of financial expenses
X2 – invested capital coverage rate
X3 – debt payment capacity rate
X4 – gross operating margin rates
X5 – average duration of the provider’s loan (in days)
X6 - added value increasing rate
X7 – average duration of clients’ loan (in days)
X8 – physical investment rate.

Depending on Z value the following are identified:

− an unfavourable zone if \( Z < -0.25 \)
− an uncertainty zone if \( -0.25 \leq Z < 0.125 \)
− a favourable zone if \( Z > 0.125 \).

These models are followed by others such as Tafler method, the Robertson method, the French Commercial Credit method, the method of "credit-men" or "security-analysis" and the score function models developed in Romania by: Mănecușă și Nicolae (1996), Băileșteanu and Ivonciu (1998) and Anghel (2002).
6. Risk analysis models for bankruptcy by banking methods

Credibility is a moral and material support, an essential element without which a credit may not be granted. Gaining confidence requires knowledge of customer, which is achieved through an activity analysis and documentation for a real assessment as the patrimonial and financial situation, recognizing quality of the manufactured products and services provided relationships with partners, the professionalism of managers. When giving a loan, the bank assumes a credit risk, diminished by a careful borrower’s assessment, setting exposure limits and implementing a prudent provisioning policy when there is danger of loss.

In the analysis of the client’s business in order to understand him is continued and completed by the analysis of creditworthiness, allowing on the one hand to reduce credit risk and on the other to set an image of the client and the degree of uncertainty borne by the bank.

Creditworthiness is the financial performance of the entity certifying confidence of the bank, when applying for a bank loan, to repay loans at maturity together with the related interest [10].

In a general approach, it may be revealed a strong correlation between the creditworthiness of the customer and its default risk. Thus, the higher the customer’s creditworthiness, the lower its risk of bankruptcy.

In analysing the customer’s creditworthiness, performances in both economic-financial and non-financial terms is pursued. As to the analysis of financial issues, it involves the calculation of financial indicators based on the following documents:
- The balance sheet for the previous year, together with all notes
- Trial balance from the previous month to loan application, property condition and financial results in the quarter expired
- Income and expenditure budget for the current year
- Flow of cash and payments during the loan period
- Business plan per current year
- Situation of gross income in the previous year achieved by autonomous companies regardless the profile.

One way to prevent business risk is assessing the creditworthiness of businesses [11] [12] [13]. That is the reason why banks classify loans and investments according to debt service and initiate legal provisions in the following categories:

a. Standard loans - are loans that do not involve deficiencies and risks that could jeopardize debt management in the manner agreed in the credit agreement when the granting of the loan, the customer being creditworthy. For these types of loans the bank cannot provisioning
b. Observation loans - are granted to customers with good financial and economic results and have problems in the short term, with the current bank loan repayment (maturity rate + interest). Provisions made for this type of loan are within 5% of the loan and can be included in expenses.
c. Substandard loans - are loans that may have weaknesses and risks that may jeopardize the debt liquidation, being insufficiently protected by the net capital and / or the borrower’s ability to pay. The level of provisions in this case is 20%.
d. Doubtful loans - are those loans for which repayment or liquidation of conditions, values and existing guarantees is uncertain. Provision level is 50% of the loans granted
e. Loss loans - are those loans that cannot be returned to the bank. Level of specific provision in this case is 100%.[14]

Based on the analysis of economic and financial performance, according to the score obtained on non-financial and financial criteria, entities fall into a category or another. Debt service is the debtors’ ability to honour debt maturity, expressed in number of days of delay in payment since the due date.

Considering the foregoing, many banks (Romanian Commercial Bank, the Romanian Bank for Development Groupe Societe Generale SA, the Bank, the Bank Agricola, Transylvania Bank, Ion Tiriac Commercial Bank, Romanian Bank) have tried to meld their own ways of evaluating the financial performance of organizations.

Foreign banks use a complex system of assessing credit risk in order to prevent entry of organizations into bankruptcy and prevent non-recovery of loans, given a number of factors such as: rating agencies for assessing country risk like Moody’s and Standard & Poor’s, degree of financial stability, access to financial markets, debt service ability and management of balance sheet restrictions. Thus, 10 categories of ratings classified according to credit risk are obtained: excellent, strong, good, satisfactory, acceptable, marginal, in observation, standard, non-performing and rating 10 - loss [9].

7. Other methods of assessing the bankruptcy risk would be: the method of decision tree, logistic regression, methods of neurons networks and expert systems

The method of decision tree: is based on a sample of organizations classified as bankrupt or non-bankrupt, using financial ratios (for each of them setting up to a threshold value) to be answered with yes or no to the question: value of R1 rate for firm value X1 is higher or lower relative to threshold p1?. Thus, the organization is classified into subpopulation 1 (if the rate is lower than the threshold) or otherwise in subpopulation 2. In this reasoning a number of nodes (subpopulations) are obtained which in turn is divided into other subpopulations. A node can have both failed companies and non-failed ones.

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Figure 1. Graphic illustration of a decision tree for two groups of organisations (failed and non-failed)

Where:
N = N1 + N2 – total number of population
N1 – number of bankrupt/failed companies
N2 – number of non-bankrupt companies
R1, R2, R3, R4 – financial rates hold
p1, p2, p3, p4 – threshold values (inflection pointed) related to each rate/ratio
n1i – number of non-bankrupt companies in node i (for which R1i > pi)
n2i – number of bankrupt companies in node i (for which R2i ≤ pi)
i – order number of the node.

The initial node or initial population is the tree root node and the ideal situation is when the terminal node is pure if it contains only elements from one group of organizations. To build such a tree takes up the steps: determining financial ratios and the order in which they will be used to perform division, taking the decision that a given node is considered terminal or continue dividing and allocating all organizations in a cloud terminal to a group of such organization. As stated above, the ideal situation is that a tree contains only pure nodes, so they had a success rate of 100%.

Because decision trees do not always lead to conclusive results in the analysis of insolvency risk, they complement or are used in conjunction with other methods of risk analysis and expert systems

Expert systems – used in credit risk assessment, using artificial intelligence to solve the problem of the bankruptcy analysis. The method is based on a sample of organizations (healthy or in need) and with financial ratios, generates a production rule system to correctly fit all organizations in the sample. The decision tree estimated by this method is rather similar to a decision tree of the recurrent partitioning algorithm. Example of two systems using this method and multi-attribute models are: Credex (credit expert) elaborated in 1992 by Pinson and the system CGX developed in 1990 by Srinivasan and Ruparel.

8. Conclusions

As a conclusion, the scientific community must play an important role in risk measurement and presentation of information in as clear and unambiguous manner as possible, with caution regarding uncertainties. However, the company too is responsible as a whole, without separation of certain groups, preferred on the right to determine what is tolerable and acceptable, based on social, political, cultural or economic considerations, there are areas where the risk is so great that it is considered unacceptable, and other where the risk is so small that it can be considered negligible.

Legislation and human attitude and, therefore, human behaviour changes are important channels of risk reduction. Numerous hazards cannot be removed in the sense that they are out of control. Thus, reducing risk depends on reducing exposure to risk, believes Maria Gavrilescu [16].

In conclusion, the causes that may lead to failure are many and they target the reduction of business, reduction margins and rates of return, specific issues of treasury management and accidental causes of bankruptcy related to customers, reducing the markets, chain lock, etc.

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