

SYMPTOMS OF BANKRUPTCY AND PREDICTION MODELS OF BANKRUPTCY RISK

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Abstract:

This paper makes a brief literature review on symptoms of bankruptcy and prediction models of bankruptcy risk. When it comes to bankruptcy we must start from the symptoms that lead to the financial failure of a company. Financial failure or bankruptcy of a company is an event that may cause losses to banks, suppliers, shareholders and the wider community; they are interested in predicting bankruptcy of a company and how and when it will fail. Bankruptcy is often a consequence of the inefficiency of an enterprise and the decision of stakeholders to recover investments by issuing a declaration of bankruptcy. A survey of the literature shows that most international studies in failure prediction involving MDA (Multiple Discrimination Analysis).

Keywords: *bankruptcy, MDA, symptoms, predicting models, literature review.*

JEL classification: *M41*

Introduction

Specialized literature³¹ mentions the symptoms that lead to the financial fall of a company, respectively to bankruptcy. Excessive expenses, low added value, insufficient profitability, excessive investments cumulated with a lack of self-funding, lack of liquidity, increasing debt, reduced solvency, pressures from creditors, and critical liquidity are some of the symptoms that lead the company to a chronic financial block and, implicitly, to bankruptcy. The decrease of the margins and profitability ratios, less activity, difficulties encountered by the treasury and the management, as well as the bankruptcy of some customers, chain blocks, the disappearance of markets, etc. are other causes that may determine bankruptcy³². The indicators recommended to be used in analyzing the risk of bankruptcy are those concerning solvency, liquidity, treasury, and profitability.

The need to predict bankruptcy does not arise from a morbid penchant of the analysts, but because the bankruptcy or failure is real and easy to define, and the lack of forecasts results in significant losses in the economic system (first of all, for creditors and investors): in the case of quoted companies, within a four-day interval before bankruptcy is announced, investors lose approximately 41% of the capital invested in bankrupt companies, and in the case of non-quoted companies, the value drop as a result of bankruptcy and of the need for forced sale may reach 80% of the value of the company; the losses for the banks in case of credits granted to companies that go bankrupt amount to 69-72% of the credits granted to these companies³³.

³¹ Mironiuc, M., 2006, *Analiză economico-financiară. Elemente teoretico-metodologice și aplicații*, Sedcom Libris, Iași, pp. 438-442.

³² Petrescu, S., 2010, *Analiză și diagnostic financiar-contabil. Ghid teoretico-aplicativ*, 3rd edition, revised and updated, CECCAR, Bucharest, pp. 259-260.

³³ Vâlceanu, Gh., Robu, V., Georgescu, N., 2005, *Analiză economico-financiară*, Second edition, revised and updated, Editura Economică, Bucharest, pp. 380-381.

International Bankruptcy Prediction Models

E. I. Altman published in 1968, in an initial form, the first model concerning the analysis of the risk of bankruptcy and the prediction of bankruptcy, also known as the Z score function.

The discriminant analysis is useful in drawing prediction or classification models of the source of observations in certain classes, established *a priori*. In this sense, with the help of the discriminant analysis, a classification system is built, based on a set of observations and specific indicators. For the Altman model, companies classified into solvable and insolvable make up the observation sets, and the considered indicators are various analysis rates of the financial situation of the companies.

The models that predict the bankruptcy risk based on the discriminant analysis (Altman, Conan-Holder) start from historical data, which can be easily deceiving. The accuracy of these models is reduced in time if the considered variables are not updated or if the model is not recalibrated, although initially the precision of the models was reasonable. Inherently, the financial ratios taken into consideration change in time, according to the various factors external or internal to the company. The models that diagnose the risk of bankruptcy, used in practice by banks, must be periodically retested. Another limitation of the models based on the discriminant analysis is that the result imposed by the model cannot refer to solvency, insolvency, and restructuring at the same time.

The Z score model developed by Altman can be used especially by companies using state capital in countries with developing economies, since it relies on solvency indicators, but in such a continuously changing environment, the profitability ratios should be included into the model.

The financial failure or bankruptcy of a company is an event that may cause significant losses for banks, suppliers, shareholders, and the entire community. This is why the banks, suppliers, shareholders, and governments are interested not only in predicting the bankruptcy of a company, but also of the moment when it will go bankrupt. Bankruptcy is often a consequence of the inefficiency in managing the financial activity of a company and the stakeholders' decision to recover their investments by issuing a bankruptcy order. Therefore, bankruptcy is a behavioral event, since two companies with similar economic and financial situations may face different situations. One company may perform its activity normally, while the other may go bankrupt because a manager, a creditor, a shareholder, or the government initiates it.

In spite of this characteristic of bankruptcy, it is possible to predict the economic/financial situation called "bankruptcy" using the financial statements of the companies. The financial and operative difficulties of a company are usually detected using the traditional analysis and financial ratios. The high bias of the traditional financial analysis methods using ratios motivated the search for mathematical models to determine the predictability of the accounting information. Ever since the 1960's, numerous studies have been made in order to adapt rigorous analyses to these behavioral events, and sophisticated methods developed later could be successfully applied in these situations; however, the original ideas of Altman³⁴ and Beaver³⁵ still prove to be powerful predictors. Stickney³⁶ claims that the financial health of a company can be seen as a life cycle, as shown in fig. no. 1.

³⁴ Altman, E.I., 1968, *Financial ratios, discriminant analysis and the prediction of corporate bankruptcy*, Journal of Finance, 23, pp. 589-609.

³⁵ Beaver, W., 1966, *Financial ratio as predictors of failures. Empirical research in accounting selected studies 1966*, Journal of Accounting Research, Vol. 5, pp. 77-111, Supplement.

³⁶ Stickney, C., 1990, *Financial Statement Analysis: A Strategic Perspective*, Harcourt Brace Jovanovich Publishers, San Diego, CA, p. 256.

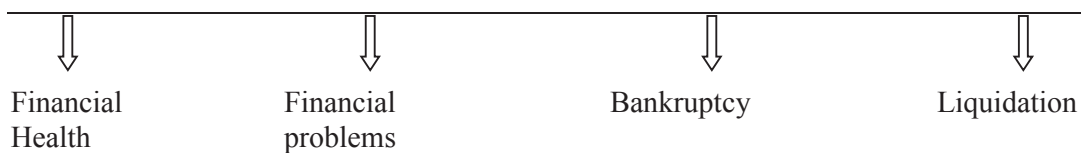


Fig. no. 1 The health of a company

Traditional risk analyses that use financial ratios try to capture the signals that show that companies will enter a time marked by financial problems or even detect possible bankruptcy before the companies declare the actual event. The models that predict bankruptcy have the same purpose, but use a more rigorous statistical analysis. The main idea is to observe the trend and behavior of the financial ratios of bankrupt companies in the years before the bankruptcy occurred and to compare them with those of companies with no financial problems, in order to determine ratios and functions that have the power to predict bankruptcy before it occurs.

The expectation is that the signals that the business declines, noticed in the behavior of the ratios, can be detected quite early and quite clearly, so that measures can be taken in time to avoid substantial risks of failing³⁷.

According to Altman³⁸, there are four steps in the development of a model for predicting bankruptcy:

- Analyzing groups of bankrupt and non-bankrupt companies in order to identify the most different financial characteristics between the groups that show a significant tendency to go bankrupt;
- Reclassifying the original sample using financial characteristics;
- Testing the predictive ability of the model on the sample;
- Using the model to predict future bankruptcies.

There are mainly two types of studies for predicting management bankruptcy: the univariate and multivariate analysis. Univariate analysis relies on the relationship between individual ratios and bankruptcy, while multivariate analysis uses multiple ratios to determine the function for predicting bankruptcy.

Various studies based on univariate analysis have shown a definitive potential of the ratios as predictors of bankruptcy. Usually, ratios that measure earnings, liquidity, and solvency remain the most significant. The order of their importance is not clearly established, since various studies mention different ratios as the most efficient indicators that help avoiding problems. Beaver³⁹ developed one of the classical papers in the field of failure analysis and classification ratios. By confronting samples of healthy and bankrupt companies, Beaver discovered that the numbers of indicators may make the difference between bankrupt and non-bankrupt companies, before failure occurs. He examined the predictive power of 30 different financial ratios, concluding that the cash flow divided by the total liabilities is the best ratio for predicting failure. His study is, in essence, a univariate analysis of a set of predictors of failure, which lay at the basis of future research based on the multivariate analysis⁴⁰.

As a matter of fact, univariate analysis have been useful, and for at least the last two decades they have been used only to professional purposes. Altman, referring to

³⁷ Bernstein, L., 1993, *Financial Statement Analysis: Theory, Application and Interpretation*, 5th Ed, Richard D. Irwin, Homewood, IL, p. 645.

³⁸ Altman, E.I., Avery, R., Eseinbeis, R. and Snikey, J., 1981, *Application of classification techniques in business, banking and finance*, Contemporary Studies in Economic and Financial Analysis, Vol. 3, JAI Press, Greenwich, CT, p. 25.

³⁹ Beaver, W., 1966, *Financial ratio as predictors of failures. Empirical research in accounting selected studies 1966*, Journal of Accounting Research, Vol. 5, pp. 77-111, Supplement.

⁴⁰ Sandin, A. R., Porporato, M., 2007, *Corporate bankruptcy prediction models applied to emerging economies. Evidence from Argentina in the years 1991-1998*, International Journal of Commerce & Management, ProQuest Central, pp. 295-311.

univariate analyses, stated: "Although some important generalizations were established, taking into consideration the tendencies and performances of specific measures, adapting the results in order to evaluate a potential collapse of the company is questionable"⁴¹. He suggested that the analysis ratios presented in this form are susceptible of errors and potential confusions in interpretation; for example, a company with low incomes and high solvency is usually considered to have the potential to go bankrupt, but it can be considered not to have serious problems if its liquidity is under the average value. For this reason, ambiguity is obvious and inherent in any univariate analysis. However, relying on the results of studies that imply univariate analyses, multivariate analysis models can be built, which combine a multitude of significant measures with prediction power. Multivariate models may be classified into:

- Parametric models: such as discriminant models and conditioned probability models (logit and probit) and
- Non-parametric models: such as models with iterative partitions, Argenti's model, and neuronal models.

A review of specialized literature shows that most international studies for predicting failure imply MDA (Multiple Discriminate Analysis)⁴². However, in spite of the popularity of the MDA technique in building failure classification models, questions arose concerning the restrictive statistical requirements imposed by the models⁴³. Because of these limitations, Olhson⁴⁴ and Zmijewski⁴⁵ used the logical regression to predict what companies are subject to failure, but it has been suggested that these models are not sensitive to financial statements that are different from those used in developing the models⁴⁶. However, later references showed that they can be also applied to developing economies, despite the constraints of the models⁴⁷. Other interesting ideas for generating failure prediction models are using neuronal networks⁴⁸ and mixed logit models⁴⁹. In spite of the major advances in statistics, which took place in this field in the last two decades, MDA still remains the most popular and widely used technique for predicting failure, maybe because Type I errors are acceptably low in comparison with alternative and more complex techniques⁵⁰.

After the papers of Beaver⁵¹ and Altman⁵², a large amount of research has been performed using various statistic techniques, per industry and country, as well as

⁴¹ Altman, E.I., 1993, *Corporate Financial Distress and Bankruptcy: A Complete Guideto Predicting & Avoiding Distress of Banking and Profiting from Bankruptcy*, 2nd ed, Wiley, New York, NY, p. 181.

⁴² Altman, E.I., 1984, *The success of business failure prediction models: an international survey*, Journal of Banking & Finance, Vol. 8, pp. 171-198; Charitou, A., Neophytou, E., Charalambous, C., 2004, *Predicting corporate failure: empirical evidence for the UK*, European Accounting Review, Vol.13 No. 3, pp. 465-497.

⁴³ Olhson, J., 1980, *Financial ratios and the probabilistic prediction of bankruptcy*, Journal of Accounting Research, Vol. 18, No. 1, pp. 109-131.

⁴⁴ Ibidem

⁴⁵ Zmijewski, 1984, *Methodological issues related to the estimation of financial distress prediction models*, Journal of Accounting Research, Studies on Current Econometric Issues in Accounting Research, Vol. 22, Supplement, pp. 59-82.

⁴⁶ Grice, J., Dugan, M., 2001, *The limitations of bankruptcy prediction models: some cautions for the researchers*, Review of Quantitative Finance and Accounting, Vol. 17, pp. 151-166.

⁴⁷ Nam, J., Jinn, T., 2000, *Bankruptcy prediction: evidence from Korean listed companies during the IMF crises*, Journal of International Financial Management and Accounting, Vol. 11, No. 3, pp. 178-197.

⁴⁸ Charitou, A., Neophytou, E., Charalambous, C., 2004, *Predicting corporate failure: empirical evidence for the UK*, European Accounting Review, Vol.13 No. 3, pp. 465-497.

⁴⁹ Jones, S., Hensher, D., 2004, *Predicting firm financial distress: a mixed logit model*, The Accounting Review, Vol. 79, No. 4, pp. 1011-1038.

⁵⁰ Charitou, A., Neophytou, E., Charalambous, C., 2004, *Predicting corporate failure: empirical evidence for the UK*, European Accounting Review, Vol.13 No. 3, pp. 465-497.

⁵¹ Beaver, W., 1966, *Financial ratio as predictors of failures. Empirical research in accounting selected studies 1966*, Journal of Accounting Research, Vol. 5, pp. 77-111, Supplement.

⁵² Altman, E.I., 1968, *Financial ratios, discriminant analysis and the prediction of corporate bankruptcy*, Journal of Finance 23, 589-609.

variations of the definitions, concepts, and processes used⁵³. All these claim to have obtained better results or to have developed particular success models for industries and countries. The most popular ones for analyzing the bankruptcies of companies were the discriminant models, introduced for the first time in failure analysis by Altman⁵⁴. In spite of the relative success of the various studies, the discussions on the actual need for statistical models still continues. All the models have limitations based on the non-normality of the variables, the small size of the sample, the diversity of the activity fields, behavioral aspects, etc. Even with these limitations, the research efforts developed important concepts and instruments that can be used by investors, creditors, and governments in the field of risk analysis. Also, new models have been published, which increased the comparability with other studies that predict failure and financial differences in developing economies.

Specialized literature in the field of bankruptcy identified several important ratios for predicting it. There are no certain ratios used to predict the failure of companies. Most researchers selected the financial ratios relying on the popularity and predictive ability in previous research on bankruptcy⁵⁵.

The most common financial ratios used by researchers were net profit divided by total assets and total liabilities divided by total assets. The net profit ratio was used by Ohlson to represent growth⁵⁶. In order to explain bankruptcy in the UK, Lennox⁵⁷ used equity divided by current debt, the sales figure ratio, and the gross cash flow ratio. In order to explain bankruptcy in Korea, the results found by Nam and Jinn⁵⁸ showed that the financial expenses divided by the sales figure, coverage debts and the sales figure to be cashed in are important. Nam and Jinn's study was much more consistent than Lennox's. Zulkarnain⁵⁹ used the MDA model, which showed that total liabilities divided by total assets, the sales figure divided by current debt, the equity divided by current debt, and the market value divided by liabilities are significant in explaining the financial failure of Malaysian companies between 1980 and 1996.

Bankruptcy Prediction Models in Romania

In Romania, several bankruptcy prediction models have been developed.

A reference model for the Romanian economy is the score function designed by Ion Anghel⁶⁰. The author built the score starting from a sample of 276 companies, divided into two groups – bankrupt and companies with no financial difficulties – belonging to 12 branches of the national economy. The analysis performed on them was very rigorous and stressed important differences between the two groups of companies, for all categories of indicators involved in computing the score.

⁵³ Sandin, A. R., Porporato, M., 2007, *Corporate bankruptcy prediction models applied to emerging economies. Evidence from Argentina in the years 1991-1998*, International Journal of Commerce & Management, ProQuest Central, pp. 295-311.

⁵⁴ Altman, E.I., 1968, *Financial ratios, discriminant analysis and the prediction of corporate bankruptcy*, Journal of Finance 23, 589-609.

⁵⁵ Alkhatib, K., Al Bzour, A. E., 2011, *Predicting Corporate Bankruptcy of Jordanian Listed Companies: Using Altman and Kida Models*, International Journal of Business and Management, Vol. 6, No.3, ISSN 1833-3850, E-ISSN 1833-8119, pp. 208-215.

⁵⁶ Ohlson, J., 1980, *Financial ratios and the probabilistic prediction of bankruptcy*, Journal of Accounting Research, Vol. 18, No. 1, pp. 109-131.

⁵⁷ Lennox, C., 1999, *Identifying failing companies: A re-evaluation of the logit, probit and MDA approaches*, Journal Economics and Business, Vol. 51, No. 4, pp. 347-364.

⁵⁸ Nam, J., Jinn, T., 2000, *Bankruptcy prediction: evidence from Korean listed companies during the IMF crises*, Journal of International Financial Management and Accounting, Vol. 11, No. 3, pp. 178-197.

⁵⁹ Zulkarnain, M.S., Mohamad Ali, A.H., Annuar, M.N., Zainan Abidin, M., 2001, *Forecasting Corporate Failure in Malaysian industrial sectorial firms*, Asian Academy of Management Journal, Vol. 6, No. 1, pp. 15-30.

⁶⁰ Anghel, I., 2002, *Falimentul – radiografie și predicție*, Editura Economică, Bucharest, p. 87.

Măneucă and Nicolae⁶¹, two specialists of the National Forecast Commission, suggested, in 1996, a model for the metallurgic industry based on the observations made on a sample of 59 companies. This model relies on solving the necessary matrix for building the score function, using the Pearson empirical coefficient to select the discriminant financial ratios.

Gheorghe Băileșteanu⁶², starting from the models of Altman, Argenti, Conan, and Holder, suggests, in 1998, a model for the Romanian companies, composed of four variables.

The economist Paul Ivoniciu⁶³, after a study performed based on the data from over 50 companies in various activity fields, suggested in 1998 the Score Function model made up of six indicators.

The Robu-Mironiuc model⁶⁴ was designed based on studying a sample of 60 companies from various activity fields, quoted in the Bucharest Stock Exchange. This model designed a score function consisting of nine indicators.

Sample Selection in the Discriminant Analysis

Selecting the sample is the first step in predicting failure in what concerns the research results, and plays a vital role, since it can determine bias in classification and estimation. Refait⁶⁵ reviews all the work performed in the field of predicting failure. The author mentions three important factors related to selecting the sample, which may influence the quality of the prediction of failure.

The first factor concerns the definition of failure in business. Several studies are interested in predicting the failure of a business, its insolvency, its inability to pay interests and loans on time, restructuring debt, lowering the notation for the debtor, and so on. The results may vary considerably from one case to another, considering that the methodology implies building two sub-samples: one that contains the companies that go bankrupt and the other, the companies that do not. A company may be included in a sample or another according to the definition of failure. The second factor that may influence failure is the prediction horizon, which usually varies from one to three years. The third factor indicated by Refait⁶⁶ concerns the characteristics of the companies that compose the sample. These companies may differ significantly in terms of size and activity field. The sample must be representative for the entire economy, preserving the characteristics related to size and activity field, and also include the same number of companies that go bankrupt and that do not. Nevertheless, a very large and heterogeneous sample may bias future classification, because of the effects of size / activity field⁶⁷. Literature suggests various solutions to create a balance between the representativeness of the sample, on the one hand, and its homogeneity, in the other. Other studies are only interested in predicting the failure of companies of a certain size

⁶¹ Măneucă C., Nicolae, M., 1996, *Construirea și utilizarea funcției scor pentru diagnosticarea eficienței agenților economici*, Revista Finanțe, Credit, Contabilitate, 5, pp. 47-54.

⁶² Băileșteanu, Gh., 1998, *Diagnosis, Risk and Efficiency in Business*, Mirton Publishing House, Timișoara, 1998, p. 103.

⁶³ Ivoniciu, P., 1998, *The Analysis of the Bankruptcy Risk Using Score Method*, Finanțe-Bănci-Asigurări Journal, p. 17-19.

⁶⁴ Robu, M.-A., Mironiuc, M., Robu, I.-B., 2012, *Un model practic pentru testarea ipotezei de „going concern” în cadrul misiunii de audit financiar pentru firmele românești cotate*, Audit Financiar, Year X, no. 86-2/2012, pp. 13-24.

⁶⁵ Refait, C., 2004, *La prévision de la faillite fondée sur l'analyse financière de l'entreprise: un état des lieux*, Economie et Prévision 162(1), pp. 129-145.

⁶⁶ Refait, C., 2004, *La prévision de la faillite fondée sur l'analyse financière de l'entreprise: un état des lieux*, Economie et Prévision 162(1), pp. 129-145.

⁶⁷ Refait, C., 2004, *La prévision de la faillite fondée sur l'analyse financière de l'entreprise: un état des lieux*, Economie et Prévision 162(1), pp. 129-145.

or in a specific activity field⁶⁸. In building their sample, Mossman et al.⁶⁹ chose to select pairs of companies of the same size and in the same activity field. Each pair contained a bankrupt company and a company that was not going to go bankrupt.

Besides these three factors listed by Refait⁷⁰, other studies indicated a series of problems related to the selection of the sample. Malecot⁷¹ showed that taking into consideration the same number of companies that fail and that do not may trigger a statistical bias in predicting failure. He suggested that the ratio between the companies that fail and that do not in the sample should be the same as in the case of the population. Greene⁷² showed that when they estimate credit score models, banks normally use data from individuals and companies that have already had credits approved. Therefore, the samples used in predicting failure are usually not random.

Conclusions

A review of specialized literature shows that most international studies that predict failure imply the MDA (Multiple Discriminate Analysis). However, despite the technical popularity of MDA in building failure classification models, questions arose concerning the restrictive statistical requirements imposed by the models. Other interesting ideas for generating models for predicting failure are using neuronal networks and mixed logit models. In spite of the major advances in statistics, which took place in this field over the last two decades, MDA still remains the most popular and largely used technique for predicting failure, perhaps because the Type I error is acceptably low compared to alternative and more complex techniques.

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⁶⁹ Mossman, C.E., Bell, G.G., Swartz, L.M. and Turtle, H., 1998, *An empirical comparison of bankruptcy models*, Financial Review 33, pp. 35-54.

⁷⁰ Refait, C., 2004, *La prévision de la faillite fondée sur l'analyse financière de l'entreprise: un état des lieux*, Economie et Prévision 162(1), pp. 129-145.

⁷¹ Malecot, J.F., 1986, *Sait-on vraiment les défaillances d'entreprises?*, Economies et Sociétés 20 (12), December, pp. 55-82.

⁷² Greene, W., 1998, *Sample selection in credit-scoring models*, Japan and the World Economy 10, pp. 299-316.

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