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Financial predictors of corporate insolvency – assessment of the forecast horizon of variables in models of early warning against corporate bankruptcy

Abstract


The authors of the study put forward a hypothesis that it is possible to extend the forecast period for the models of discriminant analysis used to assess the risk of enterprise bankruptcy, focusing on the components of these functions in the form of one-dimensional predictors, i.e. the indicators most frequently included in the discriminant functions developed in Poland. Early warning about the growing risk of bankruptcy would be very valuable for any company. The dataset was constructed from all enterprises in Poland that went bankrupt in the years 2007–2013, which was the end of the research project period. Out of the 4,750 business entities that went bankrupt at that time, 2,739 filed financial statements with commercial courts. The main objective was realized using dynamic assessment of the variability of selected one-dimensional predictors of bankruptcy for all of these enterprises. Assessment of the time variability of the indicators under analysis allows conclusions on the predictive possibilities associated with early warning against insolvency of business entities. The results constitute input to the discussion on determination of the longest prognostic horizon that can be adopted in the models of discriminant analysis used to assess the risk of enterprise bankruptcy. Most of them cover an annual forecasting horizon. Only a few authors have attempted to construct models based on data from the two, three, or even four years preceding bankruptcy. The study showed that the main symptoms of the growing risk of bankruptcy in most of the surveyed enterprises are visible much earlier than one year before bankruptcy. This provides an opportunity to correct the predictive models and more time to restructure the company, to prevent bankruptcy. Therefore, the authors of the study have assessed the possibility of extending this forecast period.


Keywords: bankruptcy, insolvency, forecasting, financial analysis, early warnings

Introduction

The contemporary approach to financial analysis goes beyond the hitherto accepted *post factum* inference, and thus encourages analysts not only to draw *ex post* conclusions, but above all to perform so-called prospective inference. Such inference assumes the possibility of signaling potential adverse changes that may occur in the future in an enterprise, which are noticeable in advance based on financial statement analysis. In the literature on the subject, the trend related to building new models of early warning against enterprise bankruptcy and to the testing of the existing ones has been explored ever since the 1960s. (Altman, 1968; Beerman, 1976; Jacobs, 1994; Legault, 1987; Weinrich, 1978). Many of them were developed using discriminant analysis, which usually allows a dichotomous classification of the object tested into one of two categories: at risk of bankruptcy vs. not at risk of bankruptcy. The authors made numerous attempts to improve the models, including by trying to extend the forecast period as much as possible – up to four years preceding bankruptcy (Beerman, 1976; Rogowski, 1999). Usually, however, most of the researchers ultimately proposed models allowing a one-

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year forecast bankruptcy risk forecast period, stating at the same time that extension of this period would significantly weaken the model's predictive properties. However, these studies only took into account the values of selected indicators, and not their variability or rate of change. Taking into account the variability of indicators may enable the forecast horizon to be extended without a significant deterioration in the quality of the forecasts.

The authors of the study hypothesized that it is possible to extend the forecast horizon of bankruptcy prediction models by taking into account the variability of indicators most often used in prediction models developed in Poland (Antonowicz, 2015a; Korol, 2010; Maciejczak, 2008; Mączyńska, 2004). For this purpose, the variability of seven selected financial analysis indicators was examined in the four years preceding court declaration of bankruptcy of 2,739 companies that went bankrupt in 2007–2013.

These enterprises constituted a set of all business entities, which during the research period: (1) went bankrupt in Poland, and (2) filed annual financial statements with commercial courts (in accordance with the statutory requirements). The financial analysis indicators adopted for the study represent all the major groups of financial indicators, i.e.: (1) the financial liquidity ratios; (2) the debt service capability assessment ratios; (3) the ratios of business activity profitability; (4) the ratios of productivity of the assets engaged in the economic processes; and (5) the business activity and turnover ratios (selected two components of the cash conversion cycle) (Antonowicz, 2014). As such, a deliberately selected set of the following financial analysis indicators was analyzed in the study:

- [W1] the liquidity ratio – constituting the ratio of current assets to current liabilities, both assumed at the end of each financial year, without averaging the balance sheet items (Bednarski, 2007; Krajewski, 2009; Nehrebecka & Dzik, 2012; Sierpińska & Jachna, 2004);

$$[W1] = \text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

- [W2] the debt ratio – being the ratio of long-term and short-term debt to the total amount of the capital employed in the business activity, calculated without an annual average;

$$[W2] = \text{Debt ratio} = \frac{\text{Long – term and short – term liabilities}}{\text{Total assets}}$$

- [W3] the adjusted capital debt repayment capacity ratio – constituting the ratio of a net financial result, corrected (positive adjustment) by the amount of amortization write-offs, to the long-term and short-term debt, calculated by averaging of the balance sheet amounts;

$$[W3] = \text{Adjusted debt ratio} = \frac{\text{Net cash flow}}{\text{Total liabilities}}$$

- [W4] the receivables turnover ratio, in days – constituting a quotient of the product of the value of short-term receivables (assumed on an annual average basis) and the number of 365 days in relation to the revenues generated from the sale of products, goods and materials (Richards & Laughlin, 1980; Zaleska, 2012);

$$[W4] = \text{Receivables turnover ratio (in days)} = \frac{\text{Short – term receivables} \cdot 365}{\text{Sales revenues}}$$

- [W5] debt turnover ratio – being a quotient of the product of the value of short-term liabilities (assumed on an annual average basis) and the number of 365 days in relation to the revenues generated from the sale of products, goods and materials;

$$[W5] = \text{Liabilities turnover ratio (in days)} = \frac{\text{Short – term liabilities} \cdot 365}{\text{Sales revenues}}$$

- [W6] the return on sales ratio – being a quotient of the result on sales in relation to the generated sales revenues, assumed at the end of reporting periods (Michalski, 2008; Skoczylas, 2009);

$$[W6] = \text{Return On Sales (ROS)} = \frac{\text{Operating profit margin}}{\text{Sales revenues}}$$

- [W7] the asset productivity ratio – calculated on an annual average basis, as a quotient of the revenues generated from the sale of products, goods and materials in relation to the average annual value of the balance sheet total.

$$[W7] = \text{Productivity ratio of assets} = \frac{\text{Sales revenues}}{\text{Total assets}}$$

Methodology and organization of the research process

The basis for conducting research on the assessment of time volatility of financial analysis indicators in the four years preceding court declarations of bankruptcy of enterprises entails collection of appropriately rich analytical material, in the form of

financial data obtained from these entities. For this purpose, a database was constructed of all enterprises in Poland that went bankrupt in the years 2007–2013 (during the 7-year period of data collection). Out of the 4,750 business entities that went bankrupt at that time, 2,739 filed financial statements with commercial courts. These entities' reports from the last five years – preceding declaration of bankruptcy, were obtained through cooperation with one of the largest business intelligence agencies in Europe – InfoVeriti sp. z o.o. As such, 58% of the bankruptcy petitions filed in this period were subject to indicator analysis. The fact that in those years, on average, about 25% of bankruptcies involved non-agricultural business activity of natural persons is noteworthy (Antonowicz, 2015b). These entities do not usually maintain comprehensive bookkeeping and they settle their accounting on the basis of a revenue and expenses ledger, which, by definition, excludes these entities from a subjective indicator study.

Therefore, it can be estimated that the study actually covered not 58%, but about 77% of entities that declared bankruptcy in 2007–2013 and which, in accordance with the Accounting Act (Journal of Laws 1994, No. 121, item 591), were required to submit at least two of the five basic reporting elements, in the form of balance sheets and profit and loss accounts.

By analyzing the time variability t_{-4} to t_{-1} (from four years prior to bankruptcy to one year before declaration of bankruptcy) of the financial analysis indicators selected, the authors assessed the changes in these indicators both in their entirety (for all objects) and broken down into bankruptcy declared in the subsequent seven years (separately). The objects were divided in terms of the bankruptcy year, in order to determine whether the directions of the changes in these indicators vary significantly, depending on the year in which bankruptcy was declared.

This allowed a research hypothesis to be formulated regarding a relatively stable rate of change in the examined indicators in the four years preceding the announcement of bankruptcy by a court.

Confirmation of the hypothesis formulated in this way would allow inference on the grounds of updating the structural parameters of discriminant functions (which are used to anticipate enterprise bankruptcy) rather than making changes to their components in the form of previously selected financial analysis indicators.

Data analysis and results

The liquidity ratio, which is one of the most commonly used variables in the models of early warning against enterprise bankruptcy (Antonowicz, 2011a; Antonowicz, 2013) four years before declaration of bankruptcy, assumed, on average, the value of 1.37 j. (Figure 1, Table 2 in the appendix). This indicator is a neutral variable, i.e. it is postulated to accept values within a given range of variation. However, within the range desired, from the perspective of an assessment

of its predictive capabilities, it behaves like a stimulant. Therefore, in the period preceding declaration of bankruptcy, the average level of financial liquidity in the entities examined gradually decreased (this is visible at the level of the chain index of the dynamics, Table 2). Three years prior to the bankruptcy, [W1] accounted for 80% of the value from the year before; similarly, in subsequent periods, this was 72% and 53% one year prior to declaration of bankruptcy (t_{-1}), in relation to its average value calculated for the period t_{-2} . A year before the declaration of bankruptcy, on average, current liabilities were covered by current assets in 73% of the entities examined. The low level of standard deviation volatility (Table 1 in the appendix) might infer that, regardless of the moment when an entity goes bankrupt, the nature of the changes in financial liquidity of the enterprises going bankrupt is analogous. The research results coincide almost entirely with the research conducted by Antonowicz in 2003–2007, which showed that for a year prior to declaration of bankruptcy from the years 2003–2004, this indicator amounted to 0.72 j. (Antonowicz, 2009). Thus it can be assumed that this measure has such good predictive properties (which in most cases is an early warning *de facto* identical to its discriminant abilities) that its behavior in the period preceding the court announcement of enterprise bankruptcy is analogical, irrespective of the period assumed.

The second measure analyzed was an indicator of debt structure, often used in early warning systems. While the use of external financing may, at a sufficient level of financial leverage, be beneficial for an enterprise, from the perspective of its financial credibility, this measure should be considered as an inhibitor. Assuming the solvency criterion described in articles 10 and 11 of the Bankruptcy Act (Journal of Laws of 2003, No. 60, item 535), not only in the form of: (1) adequate coverage of short-term liabilities in the possibly liquid current assets, and (2) a correct, i.e. proportional length of the components of the cash conversion cycle, but also (3) an appropriate level of debt servicing capacity, its final assessment will also be affected by the entity's ability to self-finance its business operations. In accordance with the adopted standards for assessment of economic entities, equity should most often cover, in the long term, the assets (fixed assets) used by the enterprise. Four years prior to bankruptcy, the entities financed on average 77% of their business activity from external sources. For two consecutive years, they only slightly increased the percentage of long-term and short-term liabilities, ultimately exceeding their total assets a year prior to bankruptcy (i.e. 120%, Table 2 in the appendix). This situation, apart from the growing level of indebtedness, had to be reflected in the net losses of these entities, the value of which exceeded the initial founding capital (negative equity), which *de facto* meant "balance sheet bankruptcy" described in article 11.1 item 2 of the Bankruptcy Act (Journal of Laws of 2003, No. 60, item 535). As the third indicator [W3] analyzed shows – a negative value of the repayment capacity

ratio, corrected (*positive adjustment*) with depreciation write-offs, was adopted as early as two years prior to bankruptcy. The average rate of the value of the changes was highest one year prior to declaration of bankruptcy (in the period $t_{-1} = 329\%$, Table 2 in the appendix).

When assessing enterprise survivability on the market, proper management of the terms of deferred repayment of short-term liabilities [W5], in relation to the receivables collection period [W4], is also very important. Both these measures (expressed in days) reflect the company's ability to adequately regulate financial flows, as analyzed next to the inventory turnover cycle in the cash conversion cycle (Antonowicz, 2011b; Majeed et al., 2013; Murugesu, 2013). While it can still be assumed that the receivables collection period (Table 2, Figure 4 in the appendix) only slightly increases in the four years before bankruptcy, reaching 92 days in the t_{-1} period, absolutely adverse changes should be emphasized in the current liabilities rotation, which in the same period increase to an unacceptable average level of 306 days. It is also worth emphasizing the incomparable pace of the changes in both indicators, which, as noted above, should remain relative to each other in a rationally (and economically) justified correlation that, in the medium and a long term, results from settlement of the company's obligations, to a large extent, by materialization of the volume of receivables.

The variability of the sales profitability index presented in Figure 6 (Appendix) [W6] indicates a gradual increase in the sales losses incurred by bankrupting enterprises, which a year prior to the court adjudicated insolvency/bankruptcy was, on average, 17% of the total revenues generated from the sales (Figure 6, Table 2). The average value of this [...] is negative in the entire four-year period preceding the bankruptcy of the surveyed enterprises. This indicator, as a stimulant, should, in entities of good economic and financial standing, at least remain (analyzed horizontally, i.e. over time) at a comparable or (preferably) a higher level. It can only be accepted as a negative value at the initial assessment of the startups' activity, where the first phase of activity, which is related to investment and the need to incur unpaid fixed costs at this stage, at insufficient market penetration (i.e. with generated revenues that are too low), is below the break-even point (BEP).

The last of the indicators analyzed (also a stimulant) can be used to assess effectiveness of capital involvement, from the perspective of the generated sales revenues [W7]. The chain index of the rate of change of the average level of this indicator (Table 2) shows an almost linear course. This is shown in Figure 7 (Appendix). Analysis of this [Appendix] leads to the conclusion that a year prior to bankruptcy of enterprises, the average ratio of the revenues generated to the balance sheet total drops to 168%. The profit-margin level achieved on the sales of these enterprises, shown directly by this indicator, is, however, far insufficient to cover the total fixed costs, not to mention the

variable costs of these entities, which (as indicated above) generated losses on the sales in all four years preceding bankruptcy (W6, Table 2).

Discussion and conclusions

Analysis of the above indicators provides more interesting insights. It is understandable that, in the group of several thousand surveyed enterprises, the variation in the value of financial indicators can be significant. In fact, the coefficients of variation describing the intensity of their value volatility are, in many cases, close to and even exceed 100%. It is surprising that in each of the years analyzed, and for each indicator examined, volatility drops sharply in the t_{-3} period. If we assume the standard deviation of the [W1] index from the period t_{-4} to be 100%, then in the period t_{-3} it is only 46.1%, and for [W2] it is 81.8%, [W3] = 37.6%, [W4] = 38.2%, [W5] = 47.5%, [W6] = 49.2%, and [W7] = 80.9%. It is difficult to determine the reasons for this trend in a particular situation in a given calendar year, because seven consecutive years were observed. A deeper analysis of this trend shows that this may be due to a fundamental change in the distribution of indicators, which occurs in the t_{-3} period. Distribution of the [W6] indicator for enterprises that went bankrupt in 2012 (Figure 8 in the appendix) is a typical example. In the t_{-3} period, there are no indicator values greater than 5, while in t_{-4} they were even higher than 9. At the same time, the number of the indicators of the lowest values decreases by half. The average values (the median in the period $t_{-4} = 1.97$, $t_{-3} = 1.77$) and the skewness (skewness coefficient of $t_{-4} = 3.09$, $t_{-3} = 0.66$) decrease. In general, the distribution concentration (concentration coefficient for $t_{-4} = 21.4$; $t_{-3} = 2.75$) also increases. Changes are also visible in the level of standard deviation. Assuming standard deviation of 100% in the t_{-4} period, the decline is as much as 28.6%. In subsequent years, i.e. in t_{-2} and t_{-1} , changes are also visible, but the scale of these changes is incomparably smaller.

The above regularities are common to all indicators. They differ only in the size of these changes, but not in their nature. This observation raises many interesting questions. If forecasting models usually use the values of indicators from the t_{-1} period, which is justified by the fact that these data are most up-to-date, then at the market level the main symptoms of the threat are visible for the t_{-3} period. It seems that the above research results indicate a new path in building bankruptcy prediction models. Classic discriminatory bankruptcy forecasting models take into account only the level of values of selected indicators in their construction. Starting with Altman, subsequent models differ only in the indicators they take into account. They do not take into account the variability of the values of these indicators.

The study shows that by taking into account in the bankruptcy forecasting process not only the values of indicators from the t_{-1} period, but also the level of their changes in the period from t_{-4} to t_{-1} , it

is possible to improve the quality of the forecasts. This would mean the construction of new models, with a different structure and dynamic character. This constitutes an important contribution and encouragement for further research and construction of new predictive models.

The appendix is available in the online version of the journal.

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