THE USE OF DISCRIMINANT MODELS IN PREDICTING BANKRUPTCY OF ENTERPRISES IN THE CONSTRUCTION SECTOR

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Abstract

The problem of bankruptcy of enterprises, even if it is a natural process for the market economy and is even helpful for some theoretical conceptions, is that it also brings different kinds of threats. Yet, the prediction of these threats may reduce the negative consequences in a significant way. This paper examines the possibility of predicting the bankruptcy of enterprises in the construction industry listed at the WSE with the use of selected discriminant models.

Keywords: *bankruptcy of an enterprise, discriminant models, construction sector, prediction abilities*

1. Introduction

In 2007 the UEFA Committee announced a decision that the host countries responsible for organizing UEFA EURO 2012 would be Poland and Ukraine. This fact, along with existed delays in infrastructural investments in Poland, pointed at the construction industry as one of the biggest beneficiaries of this undertaking. This thesis was also supported by the rapid increase in share values of companies in the construction industry listed at the Warsaw Stock Exchange once the decision of UEFA Committee's was announced. Unfortunately, just before the beginning of the final stages of the championships, co-organized by Poland, the real physical situation concerning the construction industry turned out to be completely different. Numerous cases of companies not fulfilling their financial obligations to subcontractors along with the bankruptcy of other construction companies led to a point where we had to question whether it could have been possible to avoid this type of situation.

The aim of this paper is to discuss the prediction abilities of discriminant models with reference to the construction industry in Poland during preparations for EURO 2012. The results of the conducted analysis may help to answer the question if the use of the mentioned models could reduce negative economic effects connected with bankruptcy of construction companies. The financial

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analysis includes the companies from the construction industry listed on the Warsaw Stock Exchange.

2. The problem of company bankruptcies

While evaluating the financial situation of a company, it is important to establish if this company is still able to continue on with its business. Such a criterion became crucial in the case of companies from the construction industry which were functioning in the Polish market between 2008 and 2012, the results of which was a „surge" of bankruptcies affecting the construction industry directly. The extent of these bankruptcies exceeded financial problems in other sectors of the Polish economy. What is more, the importance of the bankruptcy problem is emphasized by the fact that it concerned some of the largest companies functioning in the Polish market. One of the construction industries whose shares were included in the portfolio of WIG20 (the Warsaw Stock Exchange's blue-chip index) in March 2012, may serve as an example.

The topic of problems connected with an entity's bankruptcy is not a new phenomenon in the functioning of the market economy. It is the market's natural way of self-regulation when companies which have been losing „the market game" and have ceased continuing their activity. This self-regulation results from the lack of „soft budget constraints" whose existence, as J. Kornai pointed out, was characteristic of companies functioning in socialist economies (Kornai 1985, p. 20).

While considering an entity's bankruptcy in micro-scale, the problems which result are visible directly. However, in economic theory there are also conceptions suggesting that a company's bankruptcy in macro-scale should be considered as a positive process. In particular it is worth paying attention to J. Schumpeter's view about the existence of „creative destruction" (Schumpeter 1939, p. 40). The basis of such a philosophy is the assumption that a company's bankruptcy will „free" ineffective resources used by this company and let them find a better allocation in the economic system. The power which leads to economic growth is the continuous aspiration for innovations resulting from leaving old methods of behaving in favor of new ones.

As E. Mączyńska emphasizes, the phenomenon of bankruptcy could be "as old as the hills". This problem is indirectly discussed in such economic theories of the business cycle or company life cycle. Mączyńska also adds that there is a visible lack of one compact, comprehensive theory concerning this issue. Attempts at shaping this theory may be found in the work of A. Schwartz entitled „A Normative Theory of Business Bankruptcy" (Schwartz 2004).

The reasons for bankruptcy of companies may be divided into two groups: exogenous and endogenous. Among exogenous reasons a current business cycle comes to the forefront. According to research conducted by A. Hołda, there is a strong negative correlation between the dynamics of the Polish GDP and the number of bankruptcy proceedings and debt conciliations (Hołda 2006, p. 67-68). Another essential correlation concerning the bankruptcy problem is the existence of a clear correlation between the time of a company's existence on the market and the probability of its bankruptcy (the longer the company exists, the lower probability of its bankruptcy) (Altman 1993). Among other factors which determine the bankruptcy of a given entity worth mentioning is a deficit of financial resources, insufficient flow of information, a lack of qualifications, defects in planning, family problems, and revaluation of the basic ratios. (Hołda, Pociecha 2009, p. 134-135).

An extremely crucial factor which is currently influencing the scale and intensity of bankruptcy is globalization. According to W. Szymański, „globalization dictates that it is necessary to introduce creative destruction at a pace and at the scale of the international markets" (Szymański 2005, p. 20). Internationalization also means that possible bankruptcies are not only a local, but also an international problem. It results from, as mentioned by J.A. Ocampo, S. Spiegel and J.E. Stiglitz, channels of shock transmission between domestic economies in the era of globalization (Ocampo, Spiegel, Stiglitz, p. 1-46). The first of these transmission channels exists in the real economy. To picture the effects of bankruptcy, one can imagine two cooperating foreign contracting parties, where one goes bankrupt and causes negative economic repercussions for the other, and thus a disruption in the country's economy.

The second channel is connected with the economy's finances. It occurs in a situation when there are financial connections between entities. The third of the mentioned channels is the existence of the so called „herding effects". It means that there is a sudden change in investors' expectations for the market of a given asset (country or region). This change results in a „quick escape" of „hot money" capital. This escape brings serious negative consequences for the entire economy of the country in which it is taking place. The shifting of the above mentioned effects from one country to another is not directly connected with the existence of connections in financial or real terms. The reason for this escape is the existence of information asymmetry in financial markets. According to Greenspan „financial markets are characterized by periods of irrational pessimism or optimism" (Greenspan 2007, p. 188-208).

The problem of bankruptcy does not bring consequences only for the entity that it directly concerns. To some extent it touches upon each stakeholder functioning in the environment of the company; employees, contracting parties, creditors, consumers and the country. As was mentioned above, it is becoming

more and more difficult to control these problems in light of the progression of the globalization process. Therefore, a proper institutional-legal framework is crucial for the appropriate proceeding of a company's bankruptcy process. In Poland it is contained in The Bankruptcy and Reorganization Law (Act of February 28,2003 – The Bankruptcy and Reorganization Law, Dz.U. 2003 No 60, poz 535 with changes). Regulations of bankruptcy and reorganization law have been introduced into the Polish legal system with new solutions in the field of recovery and composition proceedings. Settling outstanding liabilities by the debtor nor a debtor's excessive debt is considered premises for declaring bankruptcy according to the new regulations. A condition in order for a company to declare bankruptcy is that it possess sufficient financial resources to cover costs associated with bankruptcy proceedings.

3. Selected methods of predicting bankruptcy

The existence of a suitable institutional-legal framework enables a reduction of the causes of bankruptcy from the moment they appear. If the threat that a company with financial problems may cease operations is discovered early enough, it may allow time to find ways of reducing financial costs; that is, loss of capital by shareholders, lenders' losses resulting from non-payment of a loan, cooperators' losses resulting from non-payment of bankruptcy fees, and social costs such as unemployment (Prusak 2004, p. 165-179). For this reason various researchers, starting in the early 1960's, began researching the possibility of an early warning system against bankruptcy. In theory and practice several methods of predicting bankruptcy have been formulated. They are the following:

- one-dimensional ratio analysis,
- linear multi-dimensional discriminant analysis,
- logit and probit models,
- steps division models (decision diagrams),
- hazard models,
- expert systems,
- mathematical programming,
- neural networks,
- application of fuzzy set theory.

The first mentioned method, a one-dimensional ratio analysis, was proposed by W. Breaver (Breaver 1967). In his analysis, Breaver included 30 financial ratios for „health" companies and bankrupts up to five years before declaring bankruptcy. The result of his research was the thesis that bankrupt companies up to five years before going bankrupt were significantly different from non-bankrupt companies as to the value of analyzed financial ratios.

W. Breaver's work is considered as ground-breaking. It is worth mentioning that Breaver's work was proceeded by the works of the following authors: W. Rosendale (Rosendale 1908), J. Ramser and L. Foster (Ramser, Foster 1931) and C. Merwin (Merwin 1942). Significant contribution to the theory and practice of bankruptcy prediction were made by R.O. Edmister (Edmister 1972). He paid attention to the fact that a good quality prognoses concerning a company's existence in the market stem from the trend's analysis of financial ratios value, mainly considering its last level.

Main ratios used in the financial evaluation of a company (thus in the threat of bankruptcy) may be divided into five groups:

- liquidity ratios,
- activity (operating) ratios,
- debt ratios,
- profitability ratios,
- market ratios.

Possessing data from the financial statements of a given company, it is not difficult to calculate the value of the mentioned ratios. Unfortunately, a one-dimensional ratio analysis, apart from advantages such as simplicity and accuracy of prediction, has also numerous disadvantages. First of all, as E. Mączyńska emphasizes, many ratios may be marked with subjectivity in selecting them (Mączyńska 2001, p. 363-372). Furthermore, the arbitrary establishing of optimum value for each financial ratios is often questionable (Davis 1993, p. 45-55).

A linear multi-dimensional discriminant analysis helps in solving the problems with using a one-dimensional ratio analysis. The first one who suggested this kind of bankruptcy prediction method was E.I. Altman in 1968 (Altman 1968). He combined the classic ratio analysis with a multiple discriminant analysis. In his empirical research, Altman used data from 66 companies, half of which went bankrupt. Altman in his analysis used 22 financial ratios, then he reduced them to 5 of the most useful in predictions. Basing on historical data from the analyzed companies, he created a discriminant function which has the following expression:

$$Z_A = 1{,}2 * X_1 + 1{,}4 * X_2 + 3{,}3 * X_3 + 0{,}6 * X_4 + 1{,}0 * X_5 \quad (1)$$

where: $X_1 = \frac{working\ capital}{total\ assets}$; $X_2 = \frac{retained\ earnings}{total\ assets}$; $X_3 = \frac{EBIT}{total\ assets}$; $X_4 = \frac{market\ value\ equity}{book\ value\ of\ total\ liabilities}$; $X_5 = \frac{sales}{total\ assets}$

The value of a given discriminant function (that is critical value) which determines the group classification, either to bankrupts or non-bankrupts group, is 2,675. Thus, „healthy" entities are characterized by values higher

than 2,675. It is necessary to emphasize that the model is extremely accurate in classifying 95,4% of the total sample correctly.

Transition of the Polish economy from a centrally-planned economy to market economy caused an increase in interest in the problem of bankruptcy. In light of frequent accusations that Altman's model was not adapted to the reality of the transitioning economy, the need to create a model based on the Polish economical reality appeared. The first such model was created by E. Mączyńska (Mączyńska 1994). The discriminant function presented by Mączyńska has the following expression:

$$Z_M = 1{,}50 * X_1 + 0{,}08 * X_2 + 10{,}00 * X_3 + 5{,}00 * X_4 + 0{,}30 * X_5 + 0{,}10 * X_6 \quad (2)$$

where: $X_1 = \frac{annual\ financing\ surplus}{liabilities}$; $X_2 = \frac{total\ assets}{liabilities}$; $X_3 = \frac{financial\ result\ before\ tax}{total\ assets}$;

$X_4 = \frac{financial\ result\ before\ tax}{annual\ revenues}$; $X_5 = \frac{reserve}{annual\ revenues}$; $X_6 = \frac{annual\ revenues}{total\ assets}$

In the case of the function proposed by Mączyńska, the critical value is 0. Bankrupt companies have a value below 0.

The discriminant function for the total of companies functioning in the Polish economy, other than Mączyńska's function, was proposed by J. Gajdka and D. Stos (Gajdka, Stos 1996, p. 56). The function is expressed by the following:

$$Z_{GS} = 0{,}7732059 - 0{,}0856425 * X_1 + 0{,}0007747 * X_2 + 0{,}9220985 * X_3 + 0{,}6535995 * X_4 - 0{,}594687 * X_5 \quad (3)$$

where: $X_1 = \frac{sales\ revenue}{total\ assets}$; $X_2 = \frac{short-term\ liabilities}{cost\ of\ manufacture\ of\ products\ sold} * 360$; $X_3\ \frac{net\ profit}{total\ assets}$; $X_4 = \frac{gross\ profit}{net\ sales}$; $X_5 = \frac{total\ liabilities}{total\ assets}$.

In the case of the discriminant function proposed by J. Gajdka and D. Stos, the critical value determining classification of a company into a given group is 0,45. Above this value, companies are considered not subject to bankruptcy. Values below 0,45 determine the classification of an entity as bankrupt.

Another significant discriminant function was estimated by D. Hadaski (Hadaski 1998, p. 166). This model was checked during sample tests. Its accuracy was estimated between 83,33% and 95,74%. D. Hadasik's discriminant function has the following expression:

$$Z_{HA} = 2{,}36261 + 0{,}365425 * X_1 - 0{,}765526 * X_2 - 2{,}40435 * X_3 + 1{,}59079 * X_4 + 0{,}00230258 * X_5 - 0{,}0127826 * X_6 \quad (4)$$

where: $X_1 = \frac{current\ assets}{current\ liabilities}$; $X_2 = \frac{(current\ assets - reserve)}{current\ liabilities}$; $X_3 = \frac{total\ liabilities}{total\ assets}$;

$X_4 = \frac{(current\ assets - short-term\ liabilities)}{total\ liabilities}$; $X_5 = \frac{receivables}{sales\ revenue}$; $X_6 = \frac{reserve}{sales\ revenue}$

In Hadasik's function, the same as in the case of E. Mączyńska's function, the critical value is 0. This means that entities with value below 0 for ZHA

are in danger of bankruptcy, and those with values over 0 are not subjected to bankruptcy.

The discriminant function presented by B. Prusak (Prusak 2004, p. 165-179) has a very high prediction ability. It was based on data from 40 entities from the period between 1998 and 2002. This function is expressed by the following:

$$Z_P = -1{,}5685 + 6{,}5245 * X_1 + 0{,}1480 * X_2 + 0{,}4061 * X_3 + 0{,}40616 * X_4 \quad (5)$$

where: $X_1 = \frac{operating\ profit}{annual\ average\ of\ assets}$; $X_2 = \frac{costs\ of\ basic\ operating\ activity}{average\ short-term\ liabilities^3}$; $X_3 = \frac{current\ assets^4}{short-term\ liabilities}$; $X_4 = \frac{operating\ profit}{average\ short-term\ liabilities}$.

In B. Prusak's model a company is subjected to bankruptcy if the value for its Zp function is lower than -0,13. In order to include a company in a group of „healthy" companies, its function's value has to be over 0,65.

The next discriminant function for the companies functioning in Poland is presented by A. Hołda (Hołda 2006, p. 80). In Hołda's model explanatory variables are financial ratios which describe profitability, liquidity and debts. This model is characterized by a high forecasting accuracy (in tests it reached over 80% of accuracy). Hołda's function is expressed in the following manner:

$$Z_H = -0{,}073 + 4{,}015 * X_1 + 0{,}587 * X_2 + 0{,}78 * X_3 \quad (6)$$

where: $X_1 = \frac{sales\ returnes\ (loss)}{costs\ of\ operating\ activity}$; $X_2 = \frac{current\ assets}{short-term\ liabilities}$; $X_3 = \frac{liabilities+reserve+RMB}{total\ assets}$.

What is more, A. Hołda is also the author of a discriminant function prepared only for entities in the construction sector. The discriminant model created by him is characterized by a high classification ability in a „learning group". The discussed function is expressed as the following:

$$Z_H = 1{,}466 - 3{,}101 * X_1 - 0{,}015 * X_2 + 2{,}629 * X_3 \quad (7)$$

where: $X_1 = \frac{net\ cash\ from\ investment\ activity}{total\ assets}$; $X_2 = \frac{short-term\ receivables}{total\ trading\ revenue}$; $X_3 = \frac{net\ profit\ (loss)+\ result\ from\ previous\ years}{short-term\ liabilities}$

For both Hołda's discriminant functions (the first one made for all companies and the second one for the construction sector) the critical value is 0. The companies for which the value of discriminant function is over 0 are not in danger of bankruptcy. Those companies with the function's value below 0 are classified as bankrupts.

A multi-dimensional discriminant analysis is the most popular analysis used in the contemporary practice of bankruptcy prediction. This analysis is

used in more than 30% of cases (Hołda, Pociecha 2009, p. 139). Unfortunately, the use of this method has some disadvantages too. They are the following:

- a lack of opportunity to make a content-related interpretation of a synthetic meter,
- a high level of generalization and synthesis,
- difficulties connected with the creation of discriminant model with reference to a specific company basing on dynamic data,
- a lack of complete comparison of data between each unit (it results from differences in accounting's policy)
- difficulties in getting an access to empirical data (Nowak 2002, 157-163).

Apart from the discussed methods, a one-dimensional ratio analysis and discriminant analysis, as well as a logit analysis play a significant role in the practice of predicting bankruptcy of companies. The logit analysis is used in over 21% of processes of estimating entity's ability in continuing its business (Hołda, Pociecha 2009, p. 139). Logit models belong to the group of models in which the explanatory variable has only two values or models of binary classification. What is more, logit models are characterized by the existence of logit, that is, the log-odss unit. The first scholar who constructed a logit model was J. Ohlson in 1980 (Ohlson 1980). M. Gruszczyński (Gruszczyński 2001) and D. Wędzki (Wędzki 2005) created logit models for the Polish entrepreneurs.

4. Prediction abilities of selected discriminant models

The presentation of methods used in predicting bankruptcy of companies proved that the linear discriminant analysis is the most popular method among practitioners. Additionally, the models constructed according to this method are characterized by a high accuracy of forecasting the company's future situation. Therefore, formulas based on this analysis were selected to check their prediction abilities in the case of construction companies listed on the Warsaw Stock Exchange. Among numerous models of that kind, research was based on works by E.I. Altman, E. Mączyńska, J. Gajdka and D. Stos, D. Hadasik, B. Prusak and A. Hołda.

The crucial category in estimating the model's prediction quality is its power. It specifies how precisely this model divides a group of companies into entities not subjected to bankruptcy and bankrupts (Stein 2002, p.1). In this context also important are categories such as estimation failure of the 1st and 2nd type. The first one means, that the unit which in reality went bankrupt was recognized as a „healthy" unit. Failure of the 2nd type points to the idea that the unit which was not subjected to bankruptcy was recognized as a bankrupt.

Even though failures in both categories are important in describing the quality of a model, while analyzing the situation of the construction industry and negative consequences of bankruptcy of its meaningful companies, it seems that failure of the 1st type is more significant. In other words, this kind of failure should be kept to a minimum.

A group of companies, on which an estimation of power of the mentioned discriminant models was based, are construction companies listed at the WIG-construction index. This index includes all construction industry companies whose share are quoted on the Warsaw Stock Exchange. What is more, the research also includes companies which went bankrupt in 2012 and now they are not included in portfolio of index WIG-construction. Summing up, a sample of tested companies includes 28 companies, 4 of which went bankrupt in 2012. A group of bankrupts in the present research was extended to companies with an investment rating on a D level („default"), which means that two more companies are added to „bankrupts" (see Hołda, Pociecha, p. 126-132).

Data from financial statements of companies tested were introduced as explanatory variables to the discriminant models mentioned above. The obtained values were compared with the real situation of companies in 2012.

The power of Altman's model used for predicting bankruptcy of companies in 2012 on the basis of financial data from 2011 was about 42%. The value of the variable was decreasing along with the use of companies' financial data from the previous years (that is, from 2008 to 2010). What is interesting, is that Altman's model correctly pointed to all bankrupts (on the basis of data from 2011). The low power of this model results from the high value of the 2nd type failure. It results from a drop in share prices of the construction companies listed at the WSE (variable in a model), which was then the effect of increasing aversion of international investors to markets of developing countries.

E. Mączyńska's model definitely had better prediction abilities concerning the situation of construction companies in 2012. Its power's value (on the basis on data from 2011) was about 82%. This model is characterized by effective prediction abilities also using of data from the previous periods. Unfortunately, this model did not indicate correctly all bankrupts since it was characterized by a high level of 1st type failure.

J. Gajdek and D. Stos's model was also characterized by a high level of prediction abilities. Its power was 78,75% (basing on financial data from 2011). In this model prediction values were decreasing along with the use of financial data from the previous years. Unfortunately, this model did not indicate correctly all the companies from the construction industry which went bankrupt in 2012.

The next analyzed model of D. Hadasik also has a high prediction ability. The classification of companies made by this model is correct to the level of 82% (according to data from 2011). Yet, this model correctly predicted the bankruptcy of only one company. What is interesting also is that the failure of the 1st type is increasing along with the use of data from the previous years.

The model of B. Prusak is characterized by low power (especially while comparing with the models described above). Its advantage is a correct indication of all bankrupts. Additionally, basing on data from 2012, this model indicated only one company which went bankrupt in 2012 as a „non-bankrupt".

Both Hołda's models, the first one for all companies and the second one created only for the construction sector, are characterized by a high level of power: 85% and 79%. These models are characterized by a high prediction ability of company's situation in 2012, also with the use of data from the years before 2011. It means that these models sent signals about possible bankruptcy in advance. The model created only for the construction sector has better results with regard to the 1st type failure. Using this model (on the basis on data from 2011) it was possible to correctly indicate all companies which went bankrupt in 2012. What is more, this model up to 2 years in advance failed to indicate correctly only one bankrupt. Table 1 presents a matrix of classification's results for the A. Hołda's model (for the construction sector) with the use of the company's financial data from 2011.

Table 1. A matrix of classification results made with the use of A. Hołda's model for the companies in the construction sector

		Situation of companies forecasted at the end of 2011	
		bankruptcy	avoiding bankruptcy
Real situation of a company	bankruptcy	6	0
	avoiding bankruptcy	6	16

Significant information concerning the future condition of a company in the construction sector may be obtained also from an analysis of the variance of the average value of the discriminant function (Hołda's authorship) for each company between 2008 and 2011. As Graph 1 indicates (the graph which presents average values of discriminant function for „bankrupts" and „non-bankrupts" companies between 2008 and 2011) there are significant differences between levels of the mentioned averages. Additionally, the direction of their changes is opposite as time goes on.

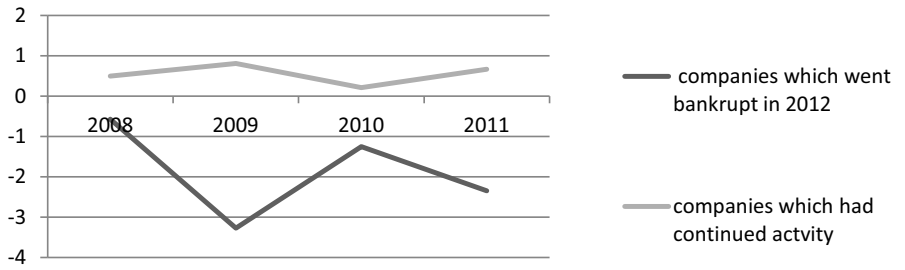

Figure 1. Average value of the discriminant function for bankrupt and non-bankrupt companies

5. Conclusions

The problem of bankruptcy of enterprises, even if it is a natural process for the market economy and is even helpful for some theoretical conceptions, is that it also brings different kinds of threats. These threats have different forms and scales depending on an entity's size and the scale of connections in the environment in which it functions. It is worth paying attention to the fact that the problems connected with bankruptcy may increase along with the progressive process of globalization. It results from the changes in the environment in which the company functions. The result of this is increasing uncertainty of the company's business activity. The increase of the mentioned threats results also from the existing problem of information asymmetry and "herding effects".

2012 brought many bankruptcies of companies functioning in the Polish construction market. The problem concerned the largest entities too. The negative effects of insolvent companies suffering from a decline also affected in a significant way the entities which cooperated with them; mainly the subcontractors. What is more, a large part of the bankruptcy costs was then imposed on the taxpayers, who had to pay twice for the same service. Therefore, it is crucial to address the question of whether the use of bankruptcy prediction might assist in pointing out the threats in advance.

Within the framework of this paper an analysis was done of financial results of companies from the construction industry listed at the Warsaw Stock Exchange between 2008 and 2011. This analysis made use of selected discriminant models. In accordance with this analysis, discriminant models seem to be the proper tools in predicting the bankruptcy of companies from the construction industry in situations such as that which took place in Poland while preparing for EURO 2012. Thus, a discriminant model is a tool which may influence reduction of negative effects of company bankruptcies in the future.

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