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Identifying Symptoms of Bankruptcy Risk Based on Polish Bankruptcy Prediction Models – a Case Study of Próchnik S.A.

Identyfikacja symptomów ryzyka bankructwa przedsiębiorstwa na podstawie polskich modeli predykcji bankructwa – *case study* Próchnik S.A.

Keywords: enterprise bankruptcy; bankruptcy prediction models; enterprise

Słowa kluczowe: bankructwo przedsiębiorstwa; modele predykcji bankructwa; przedsiębiorstwo

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Introduction

Under market economy conditions, the monitoring of a company's financial situation, including its ability to continue operations, aims to identify symptoms signalling the risk of crisis. The functioning of any company can include situations with negative consequences, including the cessation of the existence of an economic entity, which has led to the development and interest in tools that allow forecasting of bankruptcy risk of enterprises.

The problems of bankruptcy and insolvency are important from both the theoretical and practical sides of the economy. It should be noted that these phenomena constitute an indispensable element of the modern market economy and should be separated, treating bankruptcy as an economic category and insolvency as a legal category. The observed increase in the complexity of phenomena occurring in a com-

pany's environment as well as the rise in the number of bankruptcies and insolvencies of enterprises throughout the economy demonstrate the need to conduct research in this area and, at the same time, they indicate the validity and timeliness of the issue.

The aim of the article is to analyse bankruptcy prediction models and to identify the bankruptcy risk symptoms of Próchnik S.A., which announced its liquidation due to bankruptcy. The analysis was carried out using Polish bankruptcy prediction models because the different legal and tax systems or economic conditions in which Polish companies operate prevent adaptation of foreign early warning models. In determining the value of the discriminatory function of the bankruptcy prediction models, financial data from the company's financial reports for the years 2010–2017, provided by Notoria Serwis, were used.

1. The bankruptcy of the enterprise

In a market economy, one of the basic goals set for an enterprise, regardless of the type and nature of its operations, is its survival. Undoubtedly, the existence of an economic entity on the market is conditioned by ensuring its profitability and solvency, but it is not always successful. Therefore, the enterprise ceases to operate in the economy.

In the literature, the term "bankruptcy" is often used interchangeably with the term "insolvency". Treating these terms as synonymous is erroneous, as they have different scopes of meaning. Distinctions can be made on the basis of economic and legal science [Korol, Prusak, 2009, p. 12].

Bankruptcy, also referred to in the literature as economic insolvency, is defined through the prism of negative economic conditions. Bankruptcy means a long-lasting financial crisis, which usually leads to the termination of economic activity. Therefore, bankruptcy (economic insolvency) occurs when an enterprise "is not able to continue its activity independently, to have its ability to compete on the market restored and, at the same time, it shows no profitability as well as liquidity and solvency without providing external assistance" [Prusak, 2011, p. 23]. Therefore, economic insolvency refers to the financial problems of a company and a negative assessment of the financial condition described by means of a system of financial ratios characterizing various areas of the company's activity.

From an economic point of view, bankruptcy of an enterprise is closely related to the state of insolvency, with insolvency primarily being a permanent loss of ability to repay liabilities or a situation where a company's assets are insufficient to pay all liabilities [Hołda, 2006, p. 54; Olszewski, 1992, pp. 12–13]. The state of insolvency is often the result of the accumulation of negative factors persisting in the long term, such as losses, poor sales revenue, increased demand for external financing, problems with debt services, increased liabilities to suppliers (including those that are overdue), payment delays, increases in inventories, problems with

termination of investments, sales of non-current assets, etc. [Zaleska, 2002, p. 22]. As Mioduchowska-Jaroszewicz [2005, p. 11] states, "the existence and survival of enterprises depend on the ability to generate cash in the long run or to acquire it while maintaining the capital structure, i.e. having solvency". Thus, the concept of solvency refers primarily to long-term payment ability, as well as being related to the assessment of other areas of a company's financial condition.

In turn, legal bankruptcy includes court proceedings ending in the declaration of bankruptcy, which aims to "stop the build-up of debts, mitigate their effects and enable creditors to participate in the debtor's assets and eliminate weak market players" [Hamrol, Chodakowski, 2008, p. 18], and it also constitutes a compulsion to "fulfil credibility which is acceptable in the event of the debtor's insolvency or – exceptionally – in the case of excessive debt of the debtor and all his property" [Gurgul, 2000, p. 5].

The bankruptcy law clearly indicates that bankruptcy is declared in relation to a debtor who is insolvent. The basis for establishing insolvency is the existence of two economic conditions. The first of these is the permanent loss of the ability to pay off due cash liabilities, and the loss of this ability occurs when the delay in repayment of liabilities exceeds three months. The second condition for insolvency is a situation in which the debtor's financial obligations exceed the value of his assets and this state persists for a period exceeding 24 months [Ustawa z dnia 28 lutego 2003 r., Art. 1, 1a and 2]. Therefore, legal bankruptcy is associated with proceedings that include a set of rules, standards and procedures that end with the formal announcement of a company's bankruptcy.

The increased interest in the phenomenon of bankruptcy in the economy is attributable to the period of the great global crisis that took place during 1929–1933. The crisis resulted in an increased number of bankruptcies, making it necessary to seek solutions that would effectively forecast the growing financial problems of enterprises. The result of this search was the application of discriminant analysis in the study on the solvency of enterprises, the concept of which was first formulated by Fisher [1936], who introduced the notion of the discriminatory function.

Discriminant analysis, which is a collection of methods dealing with problems of discrimination and classification [Jajuga, 1993, p. 133], finds its application mainly in the classification of objects with differentiated variable characteristics [Mączyńska, Zawadzki, 2006, p. 5]. Discriminatory models are based on a discriminatory function whose task is to isolate and break down a set of objects into two or several disjunctive groups [Siemińska, 2002, p. 157].

The construction of a discriminatory model requires a teaching sample that allows estimation of discriminant function parameters and finds classification rules that are the basis for assigning objects to a given subgroup [Szewc-Rogalska, 2015, p. 166].

At the same time, this should ensure that the estimators maximize intergroup variability in comparison with intragroup variability [Kasjaniuk, 2006, p. 95]. On the basis of the fixed form of the function, the critical value of the discriminatory

function is determined – the so-called cut-off point that allows qualification of an object to a given group. In addition to the border point in the models, there is also a so-called "grey zone", which is an area of uncertainty that prevents proper allocation of the object to a separate group [Korol, 2010, p. 109]. On the basis of the estimated discriminant function, its verification is carried out using a test outside the teaching sample, i.e. checking whether the model allows proper assignation of objects to a given group. Thus, discriminant models allow assignation of the examined enterprise to a group of economic entities that are either solvent or at the risk of insolvency (bankruptcy).

An important contributor to the development of early-warning models against bankruptcy was Altman, who was the first to apply a multidimensional discriminant analysis in bankruptcy prediction [Altman, 1968, pp. 589–609]. Polish remedies in the field of bankruptcy prediction models began to arise relatively late, in the early 1990s, because it was only through the transition from the centrally planned economy to the market economy that the existence of ineffective business entities on the market was revealed, with bankruptcy being declared against these entities. Among the early-warning systems developed for the Polish economy, particular attention should be paid to the models of Mączyńska [1994, pp. 42–45], Gajdka and Stos [1996, pp. 56–65], Hadasik [1998, pp. 133–172], Hołda [2001, pp. 306–310], and Prusak [2005, p. 151], as well as the Poznań model [Hamrol et al., 2004, pp. 35–39].

Bankruptcy prediction analysis methods are the subject of numerous publications, in which they are subject to, *inter alia*, empirical verification of the prognostic effectiveness of early-warning models against the risk of bankruptcy or the usefulness of models when assessing a company's financial position. An accurate and thorough summary of the state of research on discriminatory models was made by Kitowski, who raised and put forward questions regarding the period in which the discriminant model retains its prognostic ability, the number of predicates used in the study of bankruptcy risk, and sectoral behaviour [Kitowski, 2018, p. 56; Kitowski, 2017, p. 186].

2. Research methodology

A company's financial condition can be assessed using financial analysis tools. These include models based on a discriminatory function, which allow identification of the symptoms of the risk of bankruptcy of an enterprise. The article was analysed using the example of Próchnik S.A., which declared liquidation bankruptcy in 2018. Próchnik dealt with the production and sale of men's clothing. It was one of the oldest companies listed on the Warsaw Stock Exchange and was one of the first five companies to participate in the creation of the Polish capital market as part of a free market economy. However, in recent years, the company faced many problems, including

declining sales, insufficient capital, a small number of stores, and an inappropriate collection policy, which was reflected in its deteriorating financial results. Thus, 70 years since the company's founding and after its 25-year presence on the Warsaw Stock Exchange, Próchnik announced its liquidation bankruptcy in 2018.

The company's bankruptcy risk analysis was carried out for the years 2010–2017 using six discriminant models developed by Polish researchers. In the procedure of selecting bankruptcy prediction models, two main criteria were used, on the basis of which, the selection of research tools was made. The first of these is the criterion of the period, according to which discriminant models that were created after 2000 were used in the study. This criterion was based on the assumption that, with the passage of time, the discriminant models lose their prognostic properties as a result of the difference in economic conditions between the time the model was created and the time it was applied. The second assumption adopted was the criterion of sectoral affiliation of the model. For example, on the basis of this condition, the application of the Hołda model was abandoned, as despite meeting the first criterion, it did not meet the second. Construction of the Hołda model was based on enterprises classified according to EKD (European Classification of Activities – created in Poland based on Eurostat's *Nomenclature statistique des Activités économiques dans la Communauté Européenne* – NACE rev. 1) in the group of 45 to 75, while the activity of Próchnik was assigned to group 18.22 – production of outerwear, which was the basis for excluding the model from the study.

In determining the value of the discriminatory function, financial data from the company's financial reporting for the years 2010–2017, provided by Notoria Serwis, were used. Table 1 illustrates the various discriminant models used in the study, together with the limit values of the models.

Table 1. Models of bankruptcy prediction

Model	Linear function of the discriminant model, limit value of the model
Gajdka and Stos	$Z = -0.0005x_1 + 2.0552x_2 + 1.7260x_3 + 0.1155x_4 - 0.3342$ x_1 – average value of short-term liabilities / cost of production sold; x_2 – net financial result / average balance sheet total; x_3 – gross result / net revenues from sales; x_4 – balance sheet total / total liabilities $Z \leq 0$ – "bankrupt"; $-0.49 < Z < 0.49$ – "unspecified area"; $Z \geq 0$ – "non-bankrupt"
Appenzeller and Szarzec	$Z = 0{,}819138x_1 + 2{,}566610x_2 - 0{,}00500208x_3 + 0{,}000628865x_4$ $-0{,}00951358x_5 - 0{,}556326$ x_1 – current assets / short-term liabilities; x_2 – operating profit / net sales revenues; x_3 – (average inventory value × 360) / net sales revenues; x_4 – operating cycle on days; x_5 – liabilities and provisions / (operating profit + amortization) × (12 / fiscal period); $Z < 0$ – "bankrupt"; $Z \geq 0$ – "non-bankrupt"

Model	Linear function of the discriminant model, limit value of the model
Mączyńska	$Z = 9.498x_1 + 3.566x_2 + 2.903x_3 + 0.452x_4 - 1.498$ x_1 – operating profit / total assets; x_2 – equity / total assets; x_3 – (net result + depreciation) / total liabilities; x_4 – current assets / short-term liabilities; $Z < 0$ – "bankrupt"; $Z \geq 0$ – "non-bankrupt"
Hamrol	$Z = 3.562x_1 + 1.588x_2 + 4.288x_3 + 6.719x_4 - 2.368$ x_1 – net financial result / total assets; x_2 – (current assets – inventories) / short-term liabilities; x_3 – fixed capital (equity and long-term liabilities) / total assets; x_4 – financial result from sales / net sales revenues $Z < 0$ – "bankrupt"; $Z \geq 0$ – "non-bankrupt"
Prusak	$Z = 6.5245x_1 + 0.1480x_2 + 0.4061x_3 + 2.1754x_4 - 1.5685$ x_1 – result on operating activity / average value of the balance sheet total; x_2 – operating costs (excluding other operating costs) / average value of short-term liabilities (excluding special funds and short-term financial liabilities); x_3 – current assets / short-term liabilities; x_4 – operating result / net sales revenues $Z \leq -0.13$ – "bankrupt"; $-0.13 < Z < 0.65$ – "unspecified area", $Z \geq 0.65$ – "non-bankrupt"
Maślanka	$Z = 3.73253x_1 + 8.83939x_2 + 0.04658x_3 + 0.95617x_4 - 1.6524$ x_1 – equity / total assets; x_2 – financial result from sales / total assets; x_3 – net revenues from sales / fixed assets; x_4 – cash flows from operating activities / total liabilities $Z < 0$ – "bankrupt"; $Z \geq 0$ – "non-bankrupt"

Source: Author's own study based on Stos and Gajdka [2003, p. 157], Appenzeller and Szarzec [2004, p. 128], Mączyńska [2004, p. 115], Hamrol et al. [2004, p. 38], Prusak [2005, p. 151], and Maślanka [2008, p. 196].

Table 1 shows that the bankruptcy prediction models adopted in the study are usually based on four variables (five out of six models used) that cover various areas of business performance assessment. The discriminating factors associated with variables determine the impact of individual financial indicators on the risk of bankruptcy of an enterprise.

The list presented in Table 2 regarding the group of indicators used in discriminant models shows that their construction was based on financial indicators characterizing areas of the company's activity such as liquidity, profitability, efficiency of operations and debt. The financial indicators describing profitability were the indicators most often (10 times) used in the analysed bankruptcy prediction models, while in as many as four models, the indicators from this group were used twice. Also, the models often included indicators showing financial liquidity (six times), indebtedness (five times) and performance (five times). Thus, it should be stated that individual discriminant models create a different (individual), significantly distinct set of financial indicators, by means of which the risk of bankruptcy of an enterprise is identified.

Table 2. Groups of financial ratios used in bankruptcy prediction models

Model	Indicator groups				
Gajdka and Stos	efficiency of operation	profitability	profitability	liabilities	
Appenzeller and Szarzec	liquidity	profitability	efficiency of operation	efficiency of operation	liabilities
Mączyńska	profitability	liabilities	liabilities	liquidity	
Hamrol	profitability	liquidity	liquidity	profitability	
Prusak	profitability	efficiency of operation	liquidity	profitability	
Maślanka	liabilities	profitability	profitability	liquidity	

Source: Author's own study.

3. Identification of the symptoms of bankruptcy risk – a case study of Próchnik

Bankruptcy prediction models can find their application in, among other things, an assessment and forecasting of the overall financial situation of a company and identifying the symptoms of an enterprise's risk of bankruptcy. The analysis was aimed at determining the bankruptcy risk of Próchnik, which declared liquidation bankruptcy in 2018.

The list of values of discriminatory functions (Table 3) and the matrix of classification of discriminatory models (Table 4) show that the applied bankruptcy warning systems send many converging signals that indicate the deteriorating financial situation of Próchnik. The value of discriminatory functions shows that changes between the size and direction of the dynamics of individual functions were often convergent, while the deviations from the general observed regularity may arise not only from the diverse variables adopted in the models, but also from the established values of weighting factors determining the financial situation of the company.

The values of individual functions of discriminatory models in 2017 were clearly lower compared to the observed levels in 2010, which means that between 2010 and 2017 there were a number of adverse financial situations with a negative impact on the company's position. In 2017, all discriminatory models were consistent in assessing the financial situation of Próchnik, pointing to its inability to continue operations, which formally ceased in 2018.

The existing situation can be explained by the accumulation of negative financial phenomena that occurred in the enterprise, such as a significant increase in liabilities, negative working capital, decreased revenues, negative financial results, and negative equity. During this time, there was a deterioration of most of the financial indicators relating to areas of the company's activity such as financial liquidity, operational efficiency, indebtedness and profitability, and this was despite the fact that individual researchers stressed the defining bankruptcy predictors, with all models indicating the company's insolvency in 2017.

By assessing individual bankruptcy prediction models, certain variables can be distinguished, which in the eyes of individual researchers were the most important

areas of the company's operations and which determined its financial position. Therefore, as guided by the composition of the Gajdka and Stos models, it can be concluded that the declining efficiency of property usage and problems with maintaining a positive sales profitability in the analysed period constituted the main indicators affecting the deteriorating financial situation of the enterprise. In the case of the Appenzeller and Szarzec models, the risk symptoms of bankruptcy of the company resulted mainly from growing problems with liquidity, declining profitability and declining inventory turnover. In the Mączyńska model, predictive properties were built based on variables that referred to the areas of profitability, indebtedness and liquidity. It was the problems with financial liquidity that had the greatest impact on the behaviour of the value of the discriminatory function, even though the weighting factor for this variable was the smallest. The results of the Hamrola model against the background of other early-warning systems did not provide a clear indication of which areas of the company's activity generated the highest risk of bankruptcy. Changes in the value of the function over time did not indicate an unambiguous trend, and from the behaviour of individual variables, those that had the greatest impact on the financial condition of the company were chosen. In the case of the Prusak model, the risk symptoms of Próchnik's bankruptcy should be related to problems in the area of profitability and financial liquidity. The components of the Maślanka early-warning system showed that the risk of Próchnik's bankruptcy was mainly determined by the problems with profitability and the negative cash flow from operating activities generated by the company.

Table 3. Value of discriminatory models for Próchnik during 2010–2017

Model	Years							
	2010	2011	2012	2013	2014	2015	2016	2017
Gajdka and Stos	0.746	0.153	0.036	0.555	-0.712	0.090	-0.284	-4.766
Appenzeller and Szarzec	4.172	0.626	-0.448	1.240	-0.993	1.299	-0.378	-3.334
Mączyńska	5.244	2.128	1.864	3.596	-1.224	2.590	0.307	-27.105
Hamrol	2.305	1.731	4.536	8.723	3.850	6.822	3.784	-8.831
Prusak	1.103	-0.219	-0.280	0.605	-2.008	0.254	-1.130	-10.656
Maślanka	-3.422	1.121	0.437	1.032	-0.702	0.790	-0.093	-7.428

Source: Author's own study.

The matrix of classification of discriminatory models (Table 4) reveals a number of insolvency indications of Próchnik. The Prusak model generated the greatest number of bankruptcy risk signals, indicating the risk of cessation of operations five times (2011–2012, 2014 and 2016–2017). In this model, a specific area was distinguished that made it impossible to determine whether in 2013 and 2015 the financial situation of the enterprise indicated its solvency or insolvency – the so-called "grey zone". Four signs pointing to the poor financial condition of the company were presented by the Appenzeller and Szarzec model and the Maślanka model, although the

periods in which this risk occurred did not always overlap. However, both models signalled financial problems twice, and the Hamrol model did so once. In the case of the Gajdka and Stos models, there were four periods in which it was impossible to determine whether the tested company should be classified in the group of bankrupts or non-bankrupts.

Table 4. The classification matrix of discriminatory models for Próchnik during 2010–2017

Model	Years							
	2010	2011	2012	2013	2014	2015	2016	2017
Gajdka and Stos	NB	0	0	NB	B	0	0	B
Appenzeller and Szarzec	NB	NB	B	NB	B	NB	B	B
Mączyńska	NB	NB	NB	NB	B	NB	NB	B
Hamrol	NB	NB	NB	NB	NB	NB	NB	B
Prusak	NB	B	B	0	B	0	B	B
Maślanka	B	NB	NB	NB	B	NB	B	B

NB – "non-bankrupt"; 0 – "grey area"; B – "bankrupt"

Source: Author's own study.

Summary

The article intended to indicate the main signs of bankruptcy of Próchnik, which declared liquidation bankruptcy in 2018. Based on the obtained results, it can be stated that the company underwent various financial problems over the period under consideration, with a negative impact on the company's financial situation. The most important identified risk factors that determined Próchnik's insolvency were loss of profitability, problems with financial liquidity, decreasing effectiveness of the management of the company's assets, and poor capital structure. The value of individual functions of discriminatory models at the time resulted in a declining trend, reflecting the deteriorating financial situation of Próchnik. In 2017, the value of discriminatory functions reached the lowest levels, and, at that time, the level of their dynamics was the highest.

In addition, based on the analyses carried out and the research results obtained, it should be noted that individual discriminant models present researchers' individual solutions for the selection of predicators that are a tool for classifying enterprises into the bankrupt or non-bankrupt groups. Therefore, the heterogeneous design of the models, as for the components, means a different strength of their response to the changing conditions of the company's operation, which then translates into different assessments of the company's risk of bankruptcy. Similarly, the issue of assigning specific weighting factors to particular predicators has a different impact on the assessment of a company's financial condition.

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Identyfikacja symptomów ryzyka bankructwa przedsiębiorstwa na podstawie polskich modeli predykcji bankructwa – *case study* Próchnik S.A.

Celem artykułu było wskazanie głównych symptomów ryzyka bankructwa spółki Próchnik, wobec której w 2018 r. ogłoszono upadłość likwidacyjną. Analizę i ocenę zagrożenia niewypłacalnością przeprowadzono na podstawie polskich modeli predykcji bankructwa. Badaniem objęto działalność przedsiębiorstwa w latach 2010–2017. Wśród najważniejszych zidentyfikowanych czynników ryzyka, które przesądziły o niewypłacalności spółki Próchnik, wskazano utratę rentowności, problemy z płynnością finansową, malejącą efektywność zarządzania zasobami majątkowymi przedsiębiorstwa oraz niewłaściwą strukturę kapitałową.

Identifying the Symptoms of Bankruptcy Risk Based on Polish Bankruptcy Prediction Models – a Case Study of Próchnik S.A.

The article aimed to identify the main symptoms of Próchnik's bankruptcy risk. Próchnik announced its liquidation bankruptcy in 2018. Analysis and assessment of Próchnik's risk of insolvency was based on the Polish models of bankruptcy prediction, and the study covered the activity of the company between 2010 and 2017. The most important identified risk factors that determined Próchnik's insolvency were loss of profitability, problems with financial liquidity, diminishing effectiveness of the management of the company's assets, and poor structure of capital.