# Application of the management factor and labour productivity index to assess the enterprise's bankruptcy risk

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**Abstract:** The functioning and development of an enterprise requires an appropriate level of management that can be analyzed on the basis of financial data reported by the entity. The article presents the concept of measuring the management level using the labour productivity indicator and the management level indicator. These are indicators derived from the model of the analytical production function, integrating a number of economic quantities in the field of financial analysis. This function is a financial model of natural production processes taking place in enterprises and consistent with classic cost accounting. From the point of view of the company's financial equilibrium, the question arises whether these indicators reflect the financial position of the company well enough so that they can be used to assess the risk of bankruptcy of the company. The aim of the study is a comparative analysis of the dynamics of indicators: level of management and labour productivity in enterprises threatened by collapse and those enterprises retaining the ability to continue their operational activities. The second group of enterprises was chosen using selected methods of discriminant analysis.

**Key words:** discriminant analysis, management level indicator, labour productivity index, company bankruptcy, financial analysis

## 1. Introduction

There are many goals of the existence of an enterprise, but in practice, the increase in the capital of owners is the most common. The survival and development of such an organization requires an appropriate level of management process based on the necessary financial data. Therefore, in the interest of both the owners of the company and the management is continuous monitoring of the financial condition of the company, especially the detection of threats that could lead to its collapse.

Monika Szczerbak (2007, p. 44) on the basis of her own and the predecessors' research indicates that although the catalogue of reasons for the collapse of enterprises is relatively constant, their hierarchy changes with time. The importance of global-

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DOI: 10.25944/znmwse.2019.04.131141

Zeszyty Naukowe Małopolskiej Wyższej Szkoły Ekonomicznej w Tarnowie, t. 44, nr 4, grudzień 2019
The Małopolska School of Economics in Tarnów Research Papers Collection, vol. 44, iss. 4, December 2019

ization processes and intensified competition are currently growing. This observation is consistent with the point of view of Joseph Schumpeter, who pointed to the large role of technological, product or organizational innovations in the survival and development of the company. The level of competitiveness in these areas is determined by the ability to adapt to changing market requirements. Low innovativeness in comparison with competitors increases the risk of business failure (Pieńkowska, 2005, pp. 18–25). Research confirms that the vast majority of the reasons of the collapse of enterprises are endogenous, that means, these reasons have their source inside the enterprise and are controlled by management. Less often exogenous factors, e.g. macroeconomic or legal factors contribute to the collapse of the enterprise (Boratyńska, 2009).

Company bankruptcy is usually not a sudden process but is preceded by numerous symptoms. The symptoms of a company collapse are divided into financial and non-financial (Nowak, 2008, p. 65). Financial, in particular, include deterioration of financial liquidity, decrease in profitability, systematic descent of sales revenues, deterioration of receivables collection, growing volume of liabilities and loans, increase in inventory value, in particular increase in the value of production in progress, improving liquidity by selling assets below book value, negative operating cash flows. In turn, among the non-financial symptoms of loss of ability to continue business activity, there is a significant or complete loss of key sales markets, staffing problems, technological and legal changes, a large number of lawsuits against the entity, termination of the contract with a key supplier. Both the financial and non-financial symptoms of the impending collapse of the enterprise are accompanied by a deterioration in key financial indicators. Properly conducted monitoring of financial data gives a chance to identify an increase in the risk of losing the ability to continue business activity. On this relationship are based many bankruptcy forecasting methods and models.

Methods of forecasting bankruptcy of enterprises can be divided into three groups (Korol, 2010, pp. 90–95):
   – theoretical methods (hazard models, credit risk models, entropy theory models);
   – statistical methods (logistics regression, decision trees, probit regression models, discriminant analysis models);
   – non-statistical methods (fuzzy logic, genetic algorithms, neural networks, expert systems, support vector machines methods).

The aim of the study is a comparative analysis of the dynamics of indicators: level of management and labour productivity in enterprises threatened by collapse and those enterprises retaining the ability to continue their operational activities. For the purpose of this paper discriminant analysis models, included in the group of statistical methods, were used. These models are used to assess the company's financial situation with synthetic measures. Due to the complex nature of the company's bankruptcy problem, these measures are a specific combination of various economic indexes calculated usually based on financial report data, but also based on market data. Such a model allows transforming several dimensions of the analysis of a company's financial situation into one dimension analysis (Hołda and Micherda, 2007, p. 121). The discrimination analysis model can be represented by the following formula:

$$Z = a_0 + a_1 X_1 + a_2 X_2 + \ldots + a_n X_n$$

where:

$Z$—variable explained by the model

$a_i$ —discrimination coefficients

$X_i$ —external variables.

Each discriminatory model provides a $Z$—limit value that divides companies into threatened and not threatened with bankruptcy. In addition, some models have an intermediate range of $Z$ values. It is the range of the value of the explained variable ($Z$) for which it cannot be clearly concluded whether the company is in fact threatened with bankruptcy or not (Prusak, 2005, pp. 40–49).

Edward Altman is considered as the precursor of the discriminatory modelling of corporate bankruptcy. In 1968 he published the linear discriminatory function of five financial indicators. Due to differences in the features of the economic environment, the Altman model useful in the United States performed much worse in relation to Polish enterprises. Since 1990s, many discriminatory models adapted to Polish economic realities have been created. These models are characterized by high quality prediction. The research was conducted on companies listed on the Warsaw Stock Exchange Company (Giełda Papierów Wartościowych w Warszawie S.A.). Warsaw Stock Exchange shows that the highest efficiency in forecasting the threat of bankruptcy has the model by Elżbieta Mączyńska, the so-called Poznań model and the model by Dorota Hadasik (Wojnar, 2014). These models were used in the research part of this work.

Elżbieta Mączyńska is the author and co-author of several bankruptcy forecasting models, however one of them has a high prognostic value. It is a combination of six indicators, among which dominate the return on assets and sales profitability. This model has the following form (Mączyńska, 1994; Antonowicz, 2007, p. 55):

$$Z = 1.5x_1 + 0.08x_2 + 10x_3 + 5x_4 + 0.3x_5 + 0.1x_6$$

where:

$$x_1 = \frac{earning\ before\ tax + amortization}{total\ liabilities}$$

$$x_2 = \frac{total\ assets}{total\ liabilities}$$

$$x_3 = \frac{earning\ before\ tax}{total\ assets}$$

$$x_4 = \frac{earning\ before\ tax}{revenue}$$

$$x_5 = \frac{inventory}{revenue}$$

$$x_6 = \frac{revenue}{total\ assets}$$

The limit value of the explained variable $Z$ is 0. If its value is lower than 0 or equal to this value, it means that the analyzed enterprise is under the threat of bankruptcy. The weak financial condition is represented by the value of $Z$ in the range (0; 1), only the value of $Z$ above 1 indicates good financial position of the entity.

A model developed by Mirosław Hamrol, Bartłomiej Czajka and Maciej Piechocki, known as the Poznań model, has a comparatively high predictive ability. In this model, the dominant argument of the discriminatory function is sales profitability (Hamrol, Czajka and Piechocki, 2004):

$$Z = 3.562x_1 + 1.588x_2 + 4.288x_3 + 6.719x_4 - 2.368$$

where:

$$x_1 = \frac{net\ earnings}{total\ assets}$$

$$x_2 = \frac{current\ assets - inventories}{current\ liabilities}$$

$$x_3 = \frac{fixed\ capital}{total\ capital}$$

$$x_4 = \frac{gross\ profit}{revenue}$$

In this model, a negative value of the variable $Z$ means a threat of bankruptcy, a positive absence of such a threat.

Dorota Hadasik is the author of several discriminatory models, of which the one presented below has the highest predictive ability. This model is based on asset structure indicators and sales turnover ratios relative to selected asset items. The discriminatory function has the following form (Hadasik, 1998, pp. 164–167):

$$Z = 2.3626 + 0.3654x_1 - 0.7655x_2 - 2.4043x_3 + 1.5908x_4 + 0.0023x_5 - 0.0128x_6$$

where:

$$x_1 = \frac{current\ assets}{current\ liabilities}$$

$$x_2 = \frac{current\ assets - inventory}{current\ liabilities}$$

$$x_3 = \frac{total\ liabilities}{total\ assets}$$

$$x_4 = \frac{current\ assets - current\ liabilities}{total\ liabilities\ and\ equity}$$

$$x_5 = \frac{receivables}{revenue}$$

$$x_6 = \frac{inventories}{revenue}$$

As in the Poznań model, a negative value of the variable $Z$ means a threat of bankruptcy, a positive absence of such a threat.

## 2. Indicators of management level and labour productivity as derivatives of the function of economic activity

For the purpose of this work, the management level index ($F$) and the labour productivity index ($Q$) based on a special analytical production function were used. This production model can be described as the Economic Activity Function (EAF). It quantitatively represents the economic activity of each economic entity operating for profit. It is a function of seven variables which values are obtainable from company accounting systems. This function takes into account the measurability of production inputs in monetary units (e.g. labour costs), which allows adding up their value in the product in accordance with the principles of cost accounting. As a result, EAF can be used to analyze the production process (Dobija, 2016).

The modern economy is characterized by an increase of the importance of human resources. The effectiveness of their use can determine the market success of a company or its bankruptcy. The effectiveness of using human resources in the field of financial analysis should be understood as economics of labour costs, which can be illustrated by the labour productivity index ($Q$) presented below. Optimizing a production system based on labour costs requires that the production model allows it to be transformed into production formula as a function of remuneration (labour cost).

The idea of EAF results from the statement that every economic activity generates costs and expectations of revenues exceeding costs. This leads to a formal record:

$$P = K \cdot (1 + r)$$

where:
$K$—operating costs
$r$—cost profitability.

As it can be seen, the market value of the product ($P$) is the historical cost of its production plus necessary expenses, such as costs of sales and marketing, administrative and management costs, adjusted by the cost profitability ratio ($r$). The $r$ indicator can be represented by the profitability formula:

$$r = \frac{Z}{K}$$

where $Z$ denotes the profit from economic activity. Costs $K$ can be divided into labour costs ($W$) and other costs ($B$), such as the raw materials use, services, depreciation, etc. Therefore, EAF is as follows:

$$P = (W + B) \cdot (1 + r)$$

The formula presented in this way allows to present production as a function of the remuneration of the employees of the enterprise ($W$):

$$P = W\left(1 + \frac{B}{W}\right) \cdot (1 + r)$$

Using the asset rotation ratio A, costs B can be represented as:

$$Z = \frac{B}{A}$$

then:

$$B = z \cdot A$$

As it was shown (Kozioł, Kozioł, Pyrek and Wojtowicz, 2014), wages (labour cost) are a percentage of human capital, so $W = u \cdot H$. The variable $H$ represents the human capital of all employees in the unit. Cost profitability $r = Z / K$. The variable $K$ is eliminated by the rotation ratio relative to assets $A$.

$$K = A \cdot v \qquad r = \frac{Z}{A \cdot v} = \frac{ROA}{v}$$

Substituting the obtained formula to EAF can be obtained:

$$P = W \cdot \frac{1 + z \cdot A}{u \cdot H} \cdot (1 + \frac{ROA}{v})$$

It can be seen that this function contains a set of significant variables that characterize the production process in the business entity. Particularly noteworthy are two of them: labour costs ($W$) and other quantities that contribute to labour productivity denoted by the letter $Q$, which variable is dimensionless, i.e. numeric.

$$P = W \cdot Q = W \cdot \frac{1 + z \cdot A}{u \cdot H} \cdot (1 + \frac{ROA}{v})$$

Considerations led to the labour productivity index $Q = P / W$. It can be seen that this indicator synthesizes the impact of six significant financial values and should grow in effectively conducted business activities.

Further transformation of the formula allows the identification of short-term influences represented by the management variable $F$. The Economic Activity Function offers a natural basis for presenting a non-linear model describing economic activity. Using the relation $e^a = 1 + a$ production is presented as follows:

$$P = W e^{\frac{A \cdot F}{H}}$$

where:
$A / H$—technical work equipment
$F$—management variable.

Using the dependence $W = p \cdot H$, the human capital variable $H$ is eliminated from the model by replacing it with the amount of labour cost ($W$) available from the accounting system. The value $p = 0.08$ (1 / year) denotes an 8% economic constant of potential growth (Kozioł, 2011).

After transforming the above formula, the management variable *F* is calculated as follows:

$$F = \frac{L}{A \cdot p} \cdot lnQ$$

This variable synthesizes level of human capital remuneration ($u$), rotation of non-wage costs *B* relative to assets ($z$) and ROA. This variable, just like the variable *Q*, is expected not to decrease but rather to systematically increase as a result of the economic activity. The management variable, as its name implies, is associated with its short-term nature, and therefore subject to ongoing management.

## 3. Main findings

Realizing the aim of the study, a research hypothesis was formulated, assuming that the indicators for assessing the financial situation: management level (*F*) and labour productivity (*Q*) have the ability to predict bankruptcy.

In order to verify the research hypothesis, the financial condition of 10 companies listed on the Warsaw Stock Exchange Company was analyzed. Half of them are enterprises with a positive financial condition, the other part are enterprises that have announced bankruptcy. For the first group (Table 1), the management variable F and the labour productivity index *Q* were calculated for the period of 5 years (2014–2018). In addition, it was verified using selected discriminatory models whether these enterprises were not at risk of bankruptcy. The choice of the discriminatory models: Elżbieta Mączyńska, Poznań and Dorota Hadasik was based on the research by J. Wojnar (2014) which shows that these models most accurately predict the threat of bankruptcy.

In the case of a group of enterprises in poor financial condition, the management variable and labour productivity index were calculated for the year of bankruptcy announcement and the last four years preceding the bankruptcy announcement. The level of bankruptcy risk was not investigated for these enterprises, because J. Wojnar (2014) in her study confirmed that in the case of these five companies, Mączyńska, Poznań and Hadasik models correctly classified these companies as bankrupts.

Table 1. Comparison of the value of the management variable ($F$) and the labour productivity index ($Q$) with the values of selected discriminant functions ($Z$) in enterprises not threatened with bankruptcy in the years 2014–2018

|  | 2018 | 2017 | 2016 | 2015 | 2014 | Change 2014/2018 |
|---|---|---|---|---|---|---|
| BORYSZEW S.A. | | | | | | |
| $F$ | 4.79 | 5.17 | 5.11 | 5.25 | 5.22 | −8.2% |
| $Q$ | 7.18 | 7.43 | 7.09 | 7.82 | 7.4 | −3.0% |
| $Z$—model by Mączyńska | 1.20 | 1.37 | 1.33 | 0.84 | 1.16 | |
| $Z$—Poznań model | 1.48 | 1.46 | 1.09 | 0.62 | 1.01 | |
| $Z$—model by Hadasik | 1.12 | 1.07 | 0.98 | 0.96 | 1.12 | |
| AZOTY S.A. | | | | | | |
| $F$ | 2.5 | 2.75 | 2.7 | 2.99 | 2.98 | −16.1% |
| $Q$ | 8.57 | 8.76 | 8.65 | 10.02 | 10.28 | −16.6% |
| $Z$—model by Mączyńska | 0.49 | 1.52 | 1.44 | 2.11 | 1.19 | |
| $Z$—Poznań model | 3.36 | 4.99 | 4.97 | 5.13 | 3.45 | |
| $Z$—model by Hadasik | 1.14 | 1.35 | 1.35 | 1.43 | 1.57 | |
| LOTOS S.A. | | | | | | |
| $F$ | 1.47 | 1.43 | 1.37 | 1.38 | 1.43 | 2.8% |
| $Q$ | 39.53 | 32.86 | 30.38 | 33.15 | 41.79 | −5.4% |
| $Z$—model by Mączyńska | 2.58 | 2.45 | 1.87 | 0.22 | −1.34 | |
| $Z$—Poznań model | 3.11 | 3.38 | 3.23 | 2.41 | 1.69 | |
| $Z$—model by Hadasik | 1.48 | 1.24 | 1.12 | 0.99 | 1.19 | |
| LPP S.A. | | | | | | |
| $F$ | 5.23 | 4.92 | 3.9 | 3.46 | 3.99 | 31.1% |
| $Q$ | 9.67 | 12.1 | 15.47 | 18.06 | 18.27 | −47.1% |
| $Z$—model by Mączyńska | 2.81 | 2.79 | 1.55 | 2.53 | 3.21 | |
| $Z$—Poznań model | 5.20 | 5.12 | 4.72 | 4.72 | 5.49 | |
| $Z$—model by Hadasik | 1.48 | 1.72 | 1.71 | 1.65 | 1.65 | |
| POLSAT S.A. | | | | | | |
| $F$ | 0.7 | 0.59 | 0.61 | 0.62 | 0.8 | −12.5% |
| $Q$ | 14.46 | 17.77 | 17.04 | 17.86 | 17.56 | −17.7% |
| $Z$—model by Mączyńska | 1.52 | 1.65 | 1.36 | 1.64 | 0.62 | |
| $Z$—Poznań model | 3.98 | 4.16 | 4.14 | 2.78 | 4.01 | |
| $Z$—model by Hadasik | 0.69 | 0.66 | 0.60 | 0.46 | 0.42 | |

S o u r c e: Authors' own calculation based on financial statements data.

The following conclusions follow from the data contained in Table 1:
1. There was no high dynamics of labour productivity index and management level variable among companies not at risk of bankruptcy. An exceptional case is LPP S.A., where the level of

management has increased by 31%, while the labour productivity has fallen by half. Additional information included in the financial report shows that LPP S.A. in 2016 initiated the process of moving from leasing employees to employing own employees under an employment contract. This resulted in a shift on costs booked as services of external companies to labour costs and a deterioration in the labour productivity index. An additional factor reducing labour productivity in LPP S.A. was the introduction of hourly minimum wages into the Polish legal system.

2. Discriminant analysis confirms that the companies selected for this part of the analysis are companies not at risk of bankruptcy. Only in the case of Lotos S.A. in 2014, the negative value of Mączyńska's function was recorded, indicating the threat of bankruptcy. However, the other two models classified this company as not at risk of bankruptcy.

3. Dynamics of $F$ and $Q$ indicators for Azoty S.A. shows significant similarity to the dynamics of these variables in companies threatened with bankruptcy. In the analyzed period, these indicators dropped regularly by a small amount. Discriminant analysis showed no threat of bankruptcy, however, the possible financial problems of this company are indicated by model by Mączyńska. Z-value for 2018 is 0.49 and it is placed in the area of uncertainty as to the threat of bankruptcy.

Table 2. Value of the management variable ($F$) and labour productivity index ($Q$) in the year of announcement of bankruptcy (year 0) and the preceding years (−1; −4).

| Year | 0 | −1 | −2 | −3 | −4 | Change −4/0 | Change −4/−1 |
|---|---|---|---|---|---|---|---|
| FOTA S.A. | | | | | | | |
| $F$ | 3.1 | 3.15 | 2.85 | 2.93 | 2.94 | 5.4% | 7.1% |
| $Q$ | 7.67 | 11.57 | 14.13 | 14.7 | 15.49 | −50.5% | −25.3% |
| ABM SOLID S.A. | | | | | | | |
| $F$ | 2.51 | 4.17 | 4.32 | 4.4 | 4.5 | −44.2% | −7.3% |
| $Q$ | 4.1 | 9.99 | 9.64 | 9.07 | 10.38 | −60.5% | −3.8% |
| BUDOPOL | | | | | | | |
| $F$ | −0.55 | 0.21 | 1.05 | 2.6 | 2.56 | −121.5% | −91.8% |
| $Q$ | 0.7 | 1.47 | 2.93 | 9.07 | 9.64 | −92.7% | −84.8% |
| ADVADIS S.A. | | | | | | | |
| $F$ | 3.43 | 4.79 | 4.53 | 5.23 | | −34.4% | −8.4% |
| $Q$ | 8.76 | 15.89 | 16.63 | 17.58 | | −50.2% | −9.6% |
| DREWEX S.A. | | | | | | | |
| $F$ | 3.04 | 3.86 | 4.3 | 4.64 | 4.92 | −38.2% | −21.5% |
| $Q$ | 3.11 | 3.86 | 3.86 | 4.48 | 6.29 | −50.6% | −38.6% |

S o u r c e: Authors' own calculation based on financial statements data.

The dynamics of the management variable and the labour productivity index obtained in enterprises which announced bankruptcy lead to the following conclusions (Table 2):

1. Over the four years preceding the declaration of bankruptcy by the surveyed enterprises, the $F$ and $Q$ indicators recorded a decrease in value. In the case of four enterprises, the decreases are

significant, by several dozen percent. One exception is Fota S.A., where there was no decrease in the level of management ($F$), paradoxically this value increased slightly. This is the result of the selling out of company assets in the year preceding the announcement of bankruptcy. It led to improving the important component of variable $F$, the ratio of assets turnover.

2. In order to examine the predictive possibilities of variables $F$ and $Q$, the dynamics of these indicators was calculated over a period of four years, from the fourth year before the fall to the year preceding the announcement of bankruptcy. In this case, there were also significant drops, although lower than between the fourth year and the year of announcement of bankruptcy. This means that the labour productivity index and management variable are a kind of early warning system for approaching bankruptcy.

## 4. Conclusions

The management variable and the labour productivity index have different characteristics than the $Z$-score indicators of discriminatory functions. They are used to assess the level of current management and the effectiveness of the use of human resources. Although these indicators were not designed for the assessment of bankruptcy risk, the values they measure have a direct impact on the survival and development of the enterprise. As a result, it is not possible to provide their limit values separating companies at risk of bankruptcy from those "healthy". However, the conducted research shows that the regular decrease in the values of the presented indicators ($F$) and ($Q$) denotes a deteriorating financial situation, which in the case of a significant scale of decreases leads to the bankruptcy of the enterprise. This is due to the fact that the goal of the enterprise should be a constant, gradual increase in the level of management and labour productivity. It can therefore be concluded that not value analysis but trend analysis of management variable and labour productivity can be one of the elements of the early warning system against the risk of bankruptcy.

The financial indicators used in the article take into account the level of remuneration. High dynamics in this area constitutes a certain limitation of the significance drawn using the presented research method. The research revealed the need for additional information on labour costs, as data from financial reports of enterprises mainly includes remuneration for employees on contracts. The use of personnel solutions aimed at reducing tax and insurance components of labour costs may distort the correctness of labour cost valuation. Work performed by external employees (e.g. in the form of employee leasing) or work based on self-employment is not included in reported costs of remuneration and employee benefits.

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# Wykorzystanie zmiennej zarządzania i wskaźnika produktywności pracy do oceny zagrożenia przedsiębiorstwa upadłością

**Abstrakt:** Przetrwanie i rozwój przedsiębiorstwa wymagają odpowiedniego poziomu zarządzania, który można analizować na podstawie danych finansowych wypracowanych przez jednostkę. W artykule przedstawiono koncepcję pomiaru poziomu zarządzania za pomocą wskaźnika produktywności pracy i wskaźnika poziomu zarządzania. Są to wskaźniki wywodzące się z modelu analitycznej funkcji produkcji, integrujące szereg wielkości ekonomicznych z zakresu analizy finansowej. Funkcja ta stanowi finansowe odwzorowanie naturalnych procesów produkcyjnych przebiegających w przedsiębiorstwach oraz w zgodzie z klasycznym rachunkiem kosztów. Z punktu widzenia równowagi finansowej przedsiębiorstwa pojawia się pytanie, czy wskaźniki te na tyle dobrze odzwierciedlają sytuację finansową przedsiębiorstwa, że mogą zostać wykorzystane do oceny zagrożenia upadłością przedsiębiorstwa. Celem pracy jest analiza porównawcza dynamiki wskaźników poziomu zarządzania i produktywności pracy w przedsiębiorstwach zagrożonych upadkiem oraz tych zachowujących zdolność do kontynuacji działania. Druga z wymienionych grup przedsiębiorstw została wyłoniona za pomocą wybranych metod analizy dyskryminacyjnej.

**Słowa kluczowe:** analiza dyskryminacyjna, wskaźnik poziomu zarządzania, wskaźnik produktywności pracy, upadłość przedsiębiorstwa, analiza finansowa