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ARE BANKRUPTCY MODELS ADEQUATE FOR CONDITION ASSESSMENT OF COMPANIES LISTED ON WARSAW STOCK EXCHANGE?

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Abstract The goal of this paper is to present early warning models used in the process of bankruptcy recognition that should meet the terms of good economic condition. Economic condition of a company on a capital market is good when the goal of the business is achieved, namely the increase in value, that occurs with the increase in earnings per share. The results show that the higher scores in a discriminant model, the lower the EPS growth rate. Correlation and linear regression models are applied on a group of observations from companies listed on Warsaw Stock Exchange.

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Introduction

The assessment of the economic condition is one of the main issues that both investors and management boards are focused on when analyzing companies. The purpose of a company can be defined as shareholder value creation. The growth of value is associated with the growth of earnings per share that is possible when a company is executing profitable investment projects, performing adequate liquidity strategies, and using leverage that does not reach a dangerous level.

Bankruptcy early warning models have been recently applied to answer the question of whether the economic condition of a company is good or not. If they are to be considered a reliable tool for economic assessment on a capital market, they should be related to the growth of the value represented, as it was mentioned above, by the growth of earnings per share in a positive way. The growth of EPS is the result of profitable investment project execution and efficient capital budgeting related to the growth of sales, equity, and assets.

The question of whether the economic condition of a company is good has an ambiguous answer. First, it can indicate the state in which a company is far from insolvency, often performing conservative strategies in the field of liquidity and capital structure and avoiding risk. Such a policy may, in the longer term, lead to bankruptcy due to the value deterioration if the profitability does not cover cost of capital. On the other hand, a good situation of a company is related to growing value, and it is the most important goal when investors' needs are taken into consideration. The condition of a company is good not only when it is solvent but also when its value grows, especially when listed companies are taken into consideration.

The purpose of the article is related to the analysis of the relationship between the signals provided by the bankruptcy early warning models reflected in scores of the levels and the growth of companies' value represented by the growth of EPS. The hypothesis tested in this paper is as follows: there is a negative relationship between the bankruptcy discriminant models' signals and EPS growth in companies listed on WSE. The positive results will indicate that the early warning bankruptcy models can be used for the assessment of the company's economic condition on a capital market, but the negative results will confirm the expectations that there are limitations in the direct application of these models to the economic condition of the companies' assessment.

Literature and problem analysis

The assessment of the economic condition is a continuous process that affects the decisions of managers and investors (Barauskaite & Streimikiene, 2021). To recognize the threat of insolvency that may lead to bankruptcy, early warning models were proposed by many authors starting from Beaver (1966) followed by Altman (Altman, 1968; Altman et al., 2004; Altman, 2018) and others (Ibrahem et al., 2021; Saputri, 2020), Springate Model (1978), Ohlson Logit Model (1980), Probit Zmijewski Model (1984), genetic algorithms proposed by McKee and Lensbergn (2002), Neural Networks Model by Wallace (2004) and SVM by Xie and Yu (2011). Ribeiro et al., (2012) noticed that in the last 30 years bankruptcy prediction has become a significant and difficult task and worked as an impulse for a number of studies, analyses and articles. Many scholars support this opinion (Abellán & Mantas, 2014; Adamowicz & Noga, 2017; Brezigar-Masten & Masten, 2012; Barboza, 2021). Many models have also been developed and tested for the Polish market (Gajdka & Stos, 1996; Maczyńska & Zawadzki, 2006; Stefański, 2010; Pawełek, 2017; Prusak, 2018; Pitera, 2021; Plich, 2021).

Many authors suggest that the bankruptcy early warning models can be used not only for bankruptcy forecasting but also for the general economic condition of the company assessment (Bombiak, 2010; Pitera, 2021; Olszewska & Turek, 2018; Kočišová & Mišanková, 2014). But on the other hand, other authors assume that the economic condition of a company on a capital market is good when earnings per share are growing (Danbolt, et al., 2011; Gniadkowska-Szymańska & Bolek, 2019, 2021). Increasing EPS translates into the growing market value of the company (Bustani, 2021; Cahyaningrum, 2017; Hartanti, 2019; Hristov, 2019). The issue of profitability and factors influencing it should be analysed in the context of owners and debtholders (Dakua, 2019). Appropriate and effective transformations in the company allow it to develop and improve its condition (Farrokh, 2016). There are more proposals in the literature related to the concept of a company assessment: Georgescu (2009), Mosteanu et al., (2019) Johnson and Soenen (2003), Zhang and Zheng (2012), Moghimi and Anvari (2014), Vochozka (2010).

Company performance assessment is related to the bankruptcy forecast because weak performance may cause problems with investments, operations, and liquidity. Also, in this area some sophisticated tech-

niques are proposed by many authors: Tinoco and Wilson (2013), Mohamad (2021), Dittmann et al., (2008). Summarizing the literature review, it can be stated that, on the one hand, many models for assessing the risk of bankruptcy have been developed, and on the other hand, many methods of assessing the financial condition have been proposed, but they have not been effective and spectacular enough. Therefore, bankruptcy models have started to be used for assessment and it has been argued that if a company is not in danger of bankruptcy, it is financially sound. This issue will be resolved in the next section.

Data and methods

The research is done on a group of companies listed on the Warsaw Stock Exchange in the period 2012 - 2019, representing the gap in time between the financial crisis and Covid-19 pandemic. The group of non-financial companies that were listed on the WSE throughout the entire period and belonged to the WIG index are taken into consideration. 180 companies were selected as a result. The study is based on quarterly data and prices on the last day of each quarter (data collected from Reuters, Notoria and Bloomberg).

One of the most popular discriminatory methods is the method proposed by Altman (1968) with its modifications. From the initial list of potential financial ratios five indicators were selected that predict bankruptcy of companies to the highest degree:
AW1 = Working capital/ Assets (WC/TA)
AW2 = Cumulated retained earnings/ Assets (CRE/TA)
AW3 = Operational profit/Assets (EBIT/TA)
AW4 =Market value of equity/ Book value of debt (MVE/BVD)
AW5 = Sales /Assets (S/TA)

$$ZScore = 1.2W1 + 1.4W2 + 3.3W3 + 0.6W4 + 1.0W5 \quad (1)$$

Based on Altman and Hotchkiss (2006) classification criteria for companies were developed and they are presented in Table 1.

Table 1: Criteria for classification of companies in the Altman system

Economic condition	Z - value	Rating
Safe area	8.15	AAA
	7.60	AA+
	7.30	AA-
	7.00	AA-
	6.85	A+
	6.65	A
	6.40	A-
	6.25	BBB+
	5.85	BBB
Insecure area	5.65	BBB-
	5.25	BB+
	4.95	BB
	4.75	BB-
	4.50	B+
	4.15	B
Danger area	3.75	B-
	3.20	CCC+
	2.50	CCC
	1.75	CCC-
	0.00	D

Source: Altman, E.I., Hotchkiss, E. (2006). Corporate Credit Scoring-Insolvency Risk Models, in Corporate Financial Distress and Bankruptcy, provided by stockwatch.pl.

It can be observed that the Altman's Model has become a tool for assessing the economic condition of a company in relation to the scores level.

Gajdka-Stos Model (1996) was redefined to assess the financial standing of Polish companies listed on the Warsaw Stock Exchange based on Altman's methodology. Four financial ratios were qualified for the model:

GSW1 = average annual short-term liabilities x number of days in a year / cost of production of products sold (STDx365/CGS)
GSW2 = income net/ assets (NI/TA)
GSW3 = gross profit /sales (EBT/S)
GSW4 = assets/ liabilities and provisions for liabilities (TA/TL)

Function model equation is as follows:

$$Z = -0,0005W1 + 2,0552W2 + 1,7260W3 + 0,1155W4 - 0,3342 \quad (2)$$

Altman and Gajdka - Stos models were chosen for further research in this paper. The purpose of the study is to analyze the relationship between the signals provided by the bankruptcy early warning models reflected in levels of scores and the one-year growth of EPS. The positive results will indicate that the early warning models can be used for the assessment of the company's economic condition on a capital market.

The research is composed of the following steps: first the statistical analysis of data is presented, then the correlation analysis between the growth of EPS, sales, assets and equity together with Altman and Gajdka-Stos models are presented. In the last part two cross-sectional models are tested, with independent variables represented by ratios included in Altman and Gajdka-Stos models and one-year growth of EPS as an endogenic variable.

Model 1

$$g(EPS)t0+1 = a0,\ t=0+a1AW1\ t0 + a2AW2\ t0 + a3AW3\ t0 + a4AW4\ t0 + a5AW5\ t0 + e\ t0 \quad (3)$$

Model 2

$$g(EPS)\ t0+1 = a0,\ t0 + a1GSW1\ t0 + a2GSW2\ t0 + a3GSW3\ t0 + a4GSW4\ t0 + e\ t0 \quad (4)$$

In the examined models, the lack of normality of residue distribution was found and for this reason the robust estimator model, LAD (the method of the lowest absolute values) was applied (it is used when the data has outliers).

Results

In the first step the summary statistics of the variables are presented in Table 2.

Table 2: Summary Statistics, using the observations no = 3680

Variable	Mean	Median	S.D.	Min	Max
EPS	3.4000	0.5220	28.8000	-718.0000	657.000
gEPS	0.0006	0.0000	0.0274	-0.6130	0.688
S	634.8900	113.0000	2323.7000	0.0000	31 654.000
gS	1.8800	0.0062	90.7000	-1.0000	5 475.000
TA	2540.0000	384.0000	8438.0000	23.6000	72 106.000
gTA	0.3140	0.0049	7.7600	-1.0000	350.000
E	1438.0000	200.4000	5158.0000	-54.9000	56 353.000
gE	0.3120	0.0093	7.5900	-16.9000	338.000
GSW1	248.0000	197.0000	221.0000	-783.0000	943.000
GSW2	0.0139	0.0133	0.0322	-0.6540	0.514
GSW3	0.0727	0.0801	1.7900	-78.8000	40.400
GSW4	3.0400	2.1800	6.5400	0.0000	230.000
ScoreGS	0.0607	-0.0272	3.3000	-136.0000	70.800
AW1	0.0804	0.0000	1.8800	-0.0132	99.300
AW2	0.0050	0.0060	0.0051	-0.2370	0.167
AW3	0.0139	0.0133	0.0322	-0.6540	0.514
AW4	2.0600	1.2000	6.5100	-0.4470	227.000
AW5	0.3200	0.2710	0.2210	0.0000	2.750
ScoreA	1.7000	1.1100	4.7300	-1.4500	141.000

Source: Own study.

The first problem taken into consideration is related to the correlation analysis between the growth of the company reflected in the growth of earnings, sales, assets and equity and Altman and Gajdka-Stos models with their scores. If the scoring models are designed for the financial situation of the company assessment, then they should be correlated to the growth of earnings, sales, assets and equity with the special emphasis of EPS growth in a positive way. The nature of the ratios is different and not linear and therefore the Spearman correlation is calculated for pairs of variables representing the growth and scores. The results are presented in Table 3.

Table 3: Spearman rho correlation, number of observations no = 3680

	gEPS	gS	gA	gE
Score Altman	-0.0880	-0.0600	0.0670	-0.0190
p-value	0.0000	0.0002	0.0000	0.2420
Score Gajdka-Stos	-0.2060	-0.1170	0.0380	0.0460
p-value	0.0000	0.0000	0.0198	0.0045

The correlation was assumed to be statistically significant for each p-value lower than 0.1000.
Source: Own study.

The correlation between growth of EPS and scores of both models taken into consideration is negative, indicating that the growth in EPS is related to lower scores indicating a worse situation of a company. The correlation is stronger for the Gajdka-Stos model compared to the Altman Model. Similar results were found for growth of sales and scores. In the case of the growth of assets and equity the correlation is positive and significant excluding the growth of equity and scores in the Altman Model. The growth in assets and equity do not have to indicate the growth of value, especially when investment projects that are not profitable are implemented in a company. The ratios considered in the Altman Model may be related to the growth of a company, namely growth of EPS, sales, assets and equity. The results of the analysis are presented in Table 4.

Table 4: Spearman's rho correlation, number of observations no = 3680

	gEPS	gS	gA	gE
AW1	0.0020	0.0380	0.0650	0.0030
p-value	0.9206	0.0228	0.0001	0.8459
AW2	-0.2850	-0.1020	0.0290	0.0350
p-value	0.0000	0.0000	0.0765	0.0316
AW3	-0.3260	-0.2220	0.0530	0.1820
p-value	0.0000	0.0000	0.0012	0.0000
AW4	-0.0180	0.0080	0.0540	-0.0690
p-value	0.2839	0.6264	0.0010	0.0000
AW5	-0.0710	-0.1260	0.0430	0.1000
p-value	0.0000	0.0000	0.0094	0.0000

The correlation was assumed to be statistically significant for each p-value lower than 0.1.
Source: Own study.

The growth of EPS is related in a negative way to AW2 = cumulated retained earnings/ assets (CRE/TA) and AW3=operational profit/assets (EBIT/TA). The growth of sales is related in a negative way to AW2 = cumulated retained earnings/ assets (CRE/TA) and AW3 = operational profit/assets (EBIT/TA) and AW5 = sales/ assets (S/TA) in a positive way. The growth of equity is related with AW3 = operational profit/ assets (EBIT/TA) and AW5 = sales /assets (S/TA) in a positive way.

The parameters of the model where growth gEPS is explained by the ratios included in the Altman model, based on formula (3) are presented in Table 5.

Table 5: Model 1, observations 3680, dependent variable: gEPS

	Coefficient	Std. Error	t-ratio	p-value	Sig.
Const	0.000900	0.000080	10.180	<0.0001	***
AW1	−0.000080	0.000300	−0.2236	0.8231	
AW2	−0.055500	0.190900	−0.2907	0.7713	
AW3	−0.056500	0.004400	−12.890	<0.0001	***
AW4	-0.000006	0.000005	−1.6830	0.0925	*
AW5	−0.000080	0.000100	−0.5964	0.5510	

The parameter was assumed to be statistically significant for each p-value lower than 0.1000, respectively for increasing confidence levels of 1% (***), 5% (**) and 10% (*).

Source: Own study.

Factors AW3 = operational profit/assets (EBIT/TA) influence the EPS growth in a negative way. Assets are a common denominator in the growth of earnings and AW3 = operational profit/assets and it can be concluded that the lower the level of operational profits, the higher the change of earnings. AW4 = market value of equity/ book value of debt (MVE/BVD) influence the growth of EPS in a negative way and the higher the market value the lower the growth of EPS.

Collinearity in the Model 1 was also investigated using Variance Inflation Factor (VIF) statistics and results are presented in Table 6.

Table 6: VIF test values for occurrence of collinearity of variables in Model 1

Variable	VIF Model 1
AW1	1.001
AW2	1.005
AW3	1.022
AW4	1.001
AW5	1.019

VIF test, values > 10.0 may indicate collinearity.

Source: Own study.

No collinearity was found in the tested model as it is presented in Table 6.

In the next part of the research the Gajdka-Stos Model was taken into consideration. Spearman correlation level was determined between the growth measures and ratios considered. The results are presented in Table 7.

Table 7: Spearman rho correlation, number of observations no = 3680

	gEPS	gS	gA	gE
GSW1	0.0190	0.0250	-0.0270	-0.0340
	0.2418	0.1268	0.0954	0.0421
GSW2	-0.3260	-0.2210	0.0530	0.1820
	0.0000	0.0000	0.0012	0.0000
GSW3	-0.2360	-0.1310	0.0110	0.0760
	0.0000	0.0000	0.4964	0.0000
GSW4	-0.0220	0.0040	0.0430	-0.0630
	0.1811	0.8131	0.0095	0.0001

The correlation was assumed to be statistically significant for each p-value lower than 0.1000.
Source: Own study.

The growth of earnings is related with the GSW2 = income net/ assets (NI/TA) and GSW3 = gross profit / sales (EBT/S) in a negative way, the same as the growth of sales. The growth of assets is not related to the Gajdka-Stos model indicators and the growth of equity is related to the GSW2 = income net/ assets. Other relationships are either not significant, or the relationship is very weak so the results may not be reliable.

The model where EPS growth is described by the ratios included in the Gajdka-Stos Model, based on formula (4) is presented in Table 8.

Table 8: Model 2: observations 3680, dependent variable: gEPS

	Coefficient	Std. Error	t-ratio	p-value	Sig.
const	0.00090	0.000100000	8.3710	<0.0001	***
GSW1	−0.00003	0.000070000	−0.1483	0.8821	
GSW2	−0.05320	0.009572300	−5.5610	<0.0001	***
GSW3	−0.00080	0.001335770	−0.6012	0.5478	
GSW4	−0.00008	6.52754e-06	−1.2860	0.1984	

The parameter was assumed to be statistically significant for each p-value lower than 0.1000, respectively for increasing confidence levels of 1% (***), 5% (**) and 10% (*).
Source: Own study.

The results presented in Table 8 show that GSW2 = income net/assets (NI/TA) influence the growth of EPS in a negative way. GSW2 = income net/ assets (NI/TA) and the growth of earnings have the common denominator, and it can be concluded that the lower net income is, the higher the growth of EPS in the next period.

Collinearity between the factors was also investigated using Variance Inflation Factor (VIF) statistics. The results are presented in Table 9.

Table 9: VIF test values for occurrence of collinearity of variables in Model 2

Variable	VIF Model 2
GSW1	1.000
GSW2	1.127
GSW3	1.127
GSW4	1.000

VIF test, values > 10.0 may indicate collinearity. No collinearity between variables was found in the tested models.
Source: Own study.

Discussion of the results

The results indicate that there is a negative correlation between the growth of earnings per share and discriminant scores confirming the hypothesis stated in this paper and indicating that the discriminant models' application for the company's condition assessment is limited and related solely to the issue of insolvency. The growth of sales is correlated with the scores in a negative way and this result confirms the previous conclusions because usually the growth of sales and earnings per share are correlated in a positive way. On the other hand, the growth of assets and equity is related to the discriminant scores in a positive way and this result may indicate that the capital budgeting in the surveyed companies is not effective and affects the solvency in a positive way in the present but in the future influences the value in a negative way. The discussion of results can be related to the price-earnings ratio that is referring to the value of the company.

$$P / E = \frac{P}{EPS} \; for EPS^{1}0 \tag{5}$$

where: P - market price of shares, E, EPS - net profit per share.

The Gordon-Shapiro formula can be used to determine the share price:

$$P_0 = \frac{D_1}{k_E - g} \tag{6}$$

where: P_0 - share price, D_1- dividend per share, g- expected profit growth rate, k_E - cost of equity.

Wherein D_1 is equal to:

$$D_1 = E_1(1-b) \tag{7}$$

where: b - profit retention ratio.

Thus, the integration of formulas (2) and (3) and their conversion can be reflected as:

$$\frac{P_0}{E_1} = \frac{1-b}{k_E - g} \tag{8}$$

The formula for the value of shares is presented in the equation (9) (Damodaran, 2008).

$$P_0 = \frac{E_0(1-b)(1+g)(1-\frac{(1+g)^n}{(1+k_E)^n})}{k_E - g} \tag{9}$$

The growth rate is related to the profitability and reinvestment rate of profits, therefore the growth rate can be expressed as: g = ROE × b. By dividing both sides of the equation by E_0 (representing EPS), the P / E multiplier formula can be reflected as:

$$P_0 = \frac{E_0(1-b)(1+ROExb)(1-\frac{(1+ROExb)^n}{(1+k_E)})}{k_E - ROExb} \tag{10}$$

$$P_0 = \frac{E_0(1-b)(1+g)(1-\frac{(1+g)^n}{(1+k_E)})}{k_E - g} \tag{11}$$

$$P_0 = \frac{E_0(1-b)(1+ROExb)(1-\frac{(1+ROExb)^n}{(1+k_E)^n})}{k_E - ROExb} \tag{12}$$

Based on formula (12) it can be concluded that the share value should increase along with the increase in earnings per share, profitability, and retention level as well as the decrease in the cost of capital (Gniadkowska -Szymańska & Bolek, 2018, 2021). This statement can be linked to the discriminant models analysis and separate ratios that represent strategies performed by the company.

The results of the presented analysis indicate that when the Altman Model is taken into consideration the growth of EPS is related in a negative way to accumulated retained earnings/ assets and operational profit/ assets measures. If a lot of retained earnings are reinvested in the company, the lower the growth of value indicating that companies should change the dividend policy and not reinvest income to such a degree, and especially that they reinvest cash in non- profitable investment projects which is proven by the positive relationship between growth of assets and growing discriminant scores. Moreover, the growth of operating profits is related to the growth of EPS in a negative way indicating that the costs are too high, and the operating profit is not sufficient. Considering the regression results it can be concluded that the lower the level of operating profits, the higher the growth of earnings. The ratio market value of equity/ book value of debt influences the growth of EPS in a negative way and the higher the market value the lower the growth of EPS.

In the Gajdka-Stos Model, the growth of earnings is related with the ratios: income net/ assets and gross profit /sales in a negative way, the same as the growth of sales. The higher the levels of incomes and profits, the lower the levels of EPS and sales growth. Also, the growth of income net/assets influences the growth of EPS in a negative way. It can be concluded that the lower net income is, the higher the growth in EPS in the next period.

Taking into account the results it can be concluded that both discriminant models and growth factors should be taken into account in the process of economic condition assessment.

Conclusions

In the analysis of the company's financial situation, a special emphasis is placed on aspects that may signal the risk of its insolvency. Assessing the economic condition of companies on the capital market is also associated with maximizing shareholder value. These two issues, i.e., the assessment of the economic situation related to risk of bankruptcy and growth of value should be examined simultaneously. Generally, it can be stated that the economic condition of a company on a capital market is good when its value grows together with the increase of earnings per share and a moderate risk level is reflected in the cost of equity. Aggressive strategies applied by companies to increase the growth of EPS can increase the probability of bankruptcy, mostly detected by the early warning discriminant models. The growth of value is limited by the threat of insolvency, but its absence does not mean a good financial situation.

The results of the presented research show, as it was expected, that the Gajdka-Stos Model is related to the growth of companies to a higher degree than the Altman Model. In addition, the negative relationship between earnings per share growth and sales and the results in early warning models indicate that in order to achieve value growth, a firm must pursue a more aggressive liquidity policy and have a higher level of leverage, which can be detected as a bankruptcy threat by discriminatory models. It can be concluded that a strategy that is too risky leads to bankruptcy and therefore both investors' requirements related to rates of return and managers' decisions should be balanced. Managers should focus on financial ratios that influence the growth of earnings per share to find a trade-off between solvency and value.

The practical implementation of the findings is related first to the limitations in direct application of the Altman Z-Score Model and its derivatives to the companies' condition assessment as the only tool. The model is very easy to apply and tempts us to interpret its results as definite in the analysis. Such an approach can result in the company's future value deterioration and bankruptcy delayed in time. Combining the discriminant models with value management can provide better recommendations for managers, investors and financial institutions regarding the situation of a business entity.

The task of business economic condition assessment on capital markets is necessary to support investor and manager decisions. Therefore, further analysis should focus on linking the insolvency issues with value creation in a trade-off model. Moreover, the relationship between the early warning models and rates of return could be a subject of future research.

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