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DIGITALIZATION, FINANCIAL INSOLVENCY AND BANKRUPTCY RISK FORECASTING OF BULGARIAN AGRICULTURAL ENTERPRISES

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Abstract

This paper aims to study the impact of agricultural enterprises' digitization and the performance and bankruptcy risk. Analyzing financial insolvency and predicting bankruptcy risk is a constant focus of research. Company managers and their creditors, auditors, counterparties, etc., are very interested in this issue. Many economists are constantly looking for adequate models and methods by which to establish the financial health of companies with the most significant degree of precision. This paper answers whether some of the most commonly used bankruptcy prediction models also apply in the agricultural sector. For this purpose, a study was made of the annual statistical reports of medium and large Bulgarian agricultural enterprises operating in this sector for five years. Next, the paper's authors also look for evidence that agricultural enterprises with a higher level of digitalization and application of information and communication technologies face a lower risk of bankruptcy and better performance, applying the fixed effect and probit models. The econometric analysis clearly shows a statistically significant relationship between the risk of bankruptcy and the productivity of agricultural enterprises, measured by ROA. Applying the probit model reveals a higher probability of bankruptcy for firms with lower productivity and higher leverage.

Key words**:** *livestock sector, insolvency, z-score models, digitalization, fixed effect model, probit model*

INTRODUCTION

The unpredictable character of future activity is a serious issue, faced by Bulgarian managers at present.

It affects all economic branches, without exception, which justifies the increased attention it has received. Economic research constantly explores methods for predicting the risk of eventual bankruptcy and its prevention (Agarvaletal., 2007), (Lukason 2014), (Rijanto, 2022) [1, 11, 16].

Insolvency is a term, whose legal definition states that "a merchant is declared bankrupt, either in case of insolvency, or over-indebtedness." (Commercial Law) [7].

In colloquial terms, more commonly the state of business venture failure and the inability to pay debts is called *bankruptcy*.

Numerous institutions show an interest in the dynamics and trends of insolvency and annually publish their reports on its level (COFACE, Eurostat, etc.) [6].

According to prognostic data of COFACE, Bulgaria for 2022 the number of insolvent companies amounts to 532, which represents a growth of 3.10% against 2021.

The total share of companies on a state level, which have announced insolvency, equals to 0.13%, whereas in some branches, the percentage reaches a level of 0.6%. In the agricultural sector and particularly in livestock farming, the prognostic levels fluctuate at about 0.32%.

The present situation to a large extent is a result of the current economic crisis and the restrictions posed during the Covid-19 pandemic. Despite the measures taken by the government to remedy its consequences (tax advantages, deferral of payments of social and fiscal obligations in time, paid leave schemes, simplification of administrative procedures, etc. (COFACE, 2022) [6], the growing trend of insolvency of Bulgarian companies is worrisome. Therefore, precise bankruptcy risk forecasting methods continue to engage the

attention of businesses and their funding institutions.

The object of the study are large and medium-sized Bulgarian companies from the livestock sector, while its subject is:

(a)applicability evaluation of the Z-score models of insolvency risk assessment in the same sector;

(b)revealing the cause-and-effect relationship between the stage of digitalization and the risk of bankruptcy.

The aim of this study is to evaluate the possibility for using significant statistical models for the analysis of insolvency risk and to compare the obtained results through these models and other traditional financial coefficients used in the agricultural sector, and livestock, in particular.

On this basis, the most suitable model shall be indicated, as well as comprehensive and precise investigation of the financial state of the livestock farm.

The authors of this publication attempt to prove that companies which have a higher level of digitization and operate with ICT, face a reduced risk of insolvency, and have better performance. The empirical study attempts to analyze and evaluate the relationship between the costs of innovation activity and digitization and the performance of agricultural enterprises through the return on assets. Whether agricultural enterprises exposed to a higher risk of bankruptcy have poorer performance and lower productivity is sought. Also, do the costs of innovation activity and digitization affect the risk of default, i.e., is there a positive correlation between them?

MATERIALS AND METHODS

One of the first models of insolvency risk analysis, encountered in economic research belongs to Prof. Edward Altman (Altman, 1968) [2]. Later, the same model has undergone amendments (Altman, 2000) [3], primarily in the part of coefficients before the variables and has become widely popular in the following variant:

$$\boldsymbol{Z = 1.2 * X1 + 1.4 * X2 \pm 3.3 * X3 \pm 0.6 * X4 + 0.999 * X5}$$

.....(1)

The X variables represent relations of different indicators from the financial reports of the studied enterprises.

For example, in Table 1, there are presented the indicators used by different authors for forecasting insolvency risk.

Table 1. Insolvency risk forecasting indicators

X	Altman	Springate	Poznanski	Hadasik
X1	WK/TA	WK/TA	NP/TA	CA/CL
X2	RE/TA	EBIT/TA	(CA-I)/CL	(CA-I)/CL
X3	EBIT/TA	EBT/CL	(E+NCL)/TA	TL/TA
X4	MVE/TL	S/TA	NP/S	WK/TL
X5	S/TA	-	-	R/S
X6	-	-	-	**I/S**
	Z<1.81	**Z<0.862**	**FD<0**	**ZHA<0**

Source: Own contribution.

where:

WK – Working Capital;
TA – Total Assets;
RE – Retained Earnings;
EBIT – Earnings Before Interest and Taxes;
MVE – Market Value Equity;
TL – Total Liabilities;
S – Sales;
EBT – Earnings Before Taxes
CL – Current Liabilities
NCL – Non-current Liabilities
CA – - CurrentAssets
NP – Net Profit
E – Equity
I–Inventories
R – Receivables

In 1978 Gordon Springate tests the Altman model and modifies it by using four, instead of five variables (Todorov, 2014) [17]:

$$\boldsymbol{Z = 1.03 * X1 + 3.07 * X2 \pm 0.66 * X3 \pm 0.4 * X4}$$

.....(2)

The previous two models have been developed on the basis of evidence from companies operating on the territory of, respectively, the USA and Canada. In view of the limitations of the volume of this publication, the study presents two more models, approved for companies in Eastern

Europe– the Poznanski Model and the Hadasik Model (Delev, 2015; Kiselinska, J., 2016).) [10, 13].

Both of them examine the probability of arising financial difficulties, as the former is four-factor, while the latter – six-factor.

Poznanski Model:

$$\boldsymbol{FD = 3.562 * X1 + 1.588 * X2 \pm 4.288 * X3 \pm 6.719 * X4 - 2.368}$$

..... (3)

Hadasik Model:

$$\text{ZHA} = 2.36261 + 0.365425 * \text{X1} - 0.765526 * \text{X2} - 2.40435 * \text{X3} + 1.59079 * \text{X4} + 0.00230258 * \text{X5} - 0.0127826 * \text{X6}$$

.....(4)

The presented Table 1. *Insolvency Risk Forecasting Indicators* shows some of the muse coefficients, typical for traditional financial analysis, such as profitability based on sales, assets, liquidity, etc.

Table 2. Financial sustainability and solvency indicators

№	Indicator	Formula	Threshold values
1.	*Equity Ratio*	$ER = \frac{E}{TA}$	*ER> 0.5*
2.	*Equity to Debt Ratio*	$EDR = \frac{E}{TL}$	*EDR>1*
3	*Debt Ratio*	$DR = \frac{TL}{TA}$	*DR< 0.5*
4	*Working Capital to Current Assets Ratio*	$WCAR = \frac{WK}{CA}$	*WCAR>0*
5	*Non-current Assets Financing Ratio*	$NCAFR = \frac{E + NCL}{NCA}$	*NCAFR>1*
6	*Current Ratio*	$CR = \frac{CA}{CL}$	*1.0 <CR<3.0*

Source: Todorov (2014), Mihailovetal (2013), Kasarova, 2010) [17, 15, 12].

Therefore, the study explores in further detail the analysis of probability of bankruptcy risk through the use of the above mentioned 4 (four) models, with additional assessment of financial sustainability and solvency of the analyzed companies through key financial ratios (Todorov, 2014), (Mihailovetal.,2013), (Kasarova, 2010) [17, 15, 12] (Table 2).

As most reliable among the selected methods of analysis of the bankruptcy risk, will be deemed the method that involves the closest match with the analysis results through the financial sustainability and solvency indicators.

The fixed effect models are widely used in literature for the analysis and assessment of dependencies in panel data (Bell and, Jones, 2015) [4].

They allow us to consider the existence of specific characteristics of enterprises (unit-specific effects), which appear during the performance of the activity, yet are not included as variables in the model (non-observed heterogeneity). These models allow us to correlate the descriptive variables to individual characteristics (effects) of each enterprise, α_i. The individual effects, α_i are included in the model as a constant. Each enterprise (statistical unit in our study) has different individual (specific) characteristics, expressed in the equation:

$$y_{it} = \alpha_i + \text{x}'_{it}\beta + u_{it} \text{.....(5)}$$

Variables of the model:

The dependent variable in the present study is the annual *return on assets* (ROA), measured as a ratio of the net profit to the total assets of the enterprise.

ROA is a widely used indicator for measuring company efficiency with respect to used assets.

For the purposes of econometric analysis, the ROA change is represented as a function of the following factors: income growth, bankruptcy risk, capital structure, and the subsector where the enterprise operates.

The variable that constitutes the greatest interest of this study is bankruptcy risk, which we present with the evaluation of the Altman's Z-score model. For the purposes of this analysis, we have used the obtained values for the indicator over a 5-year period.

Inviewofexaminingtheimpactonthecostsforsoftwareandotherintangibleassets, we introduce the variable *digit*, calculated as intangible assets divided by total assets. We think that the obtained coefficient is indicative for the

digitalization process in livestock firms, keeping in mind that the research and development costs tend to be sporadic, while the greatest part of the remaining ones is taken up by software expenses.

The choice of the other variables in the model is based on control variables that are widely used in economic literature.

We adopt the variable *sales growth*, measured as the growth rate of sales revenues, to trace the presence of a dependency between the percentile change of revenue and the results from business activity.

As an indicator of the differences in the capital structure of enterprises we use the variable *solvency*, calculated as a ratio of the total sum of liabilities and the own capital. The high debt level in capital structure is often viewed as preceding the shrinking of possibilities for external funding of enterprises and leading to a decrease in their profitability and investment and innovation activity. The expectations are that the high debt levels to have a negative effect on the processes of digital transformation.

We have observed the impact of the subsector, in which the enterprise operates. The firms in the sample are active in the following subsectors: dairy cattle, swine, poultry, and other animals (beekeeping).

The panel of data allows us to analyze and evaluate their change in two directions. The first one is at the level of the enterprise, so that we can trace the changes in returns within a 5-year period. Secondly, it is suitable to search for effects at the level of annual (aggregated) values among enterprises. In this study, we admit that livestock farms possess specific, individual characteristics, which also have an effect on their financial results.

For the purposes of this study, we have evaluated the following regression model with fixed effects:

$$ROA_{it} = \alpha_0 + \beta_1 Salesgrowth_{it} + \beta_2 Solvency_{it} + \beta_3 Bankruptcy_{it} + \beta_4 Subsector_{it} + \epsilon_{it} \quad \text{.....(6)}$$

In the following analysis we have attempted to examine the probability that enterprises may go bankrupt as a function of innovation and digital transformation costs through the application of the probit model, based on the relevant literature (Kovacova, M., Kliestik, T. 2017; de Haan, Leo and Kakes, Jan, A, 2012; Best and Wolf, 2015) [14, 8, 5]. Following Kovacova, M., Kliestik, T. (2017) [14] the probit model is given by:

$$P = 1\Phi(-x, \beta) = \Phi(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n) \quad \text{.....(7)}$$

The probit model, applied in the present work, is expressed in the following equation:

$$Y \left| \begin{matrix} Bankruptcy = 1\ bankruptcy\ risk \\ Bankruptcy = 0\ otherwise \end{matrix} \right. = \beta_0 + \beta_1 . ROA + \beta_2 . Digit + \beta_3 . Solvency + \beta_4 . Subsector + \gamma + \varepsilon$$

RESULTS AND DISCUSSIONS

In the present study we have included 34 Bulgarian companies from the livestock sector. According to the indicator *Average annual staff*, these are medium and large firms. The study covers a five-year period from 2017 to 2021.

The result "Lack of bankruptcy risk" is marked with "no", while "Bankruptcy risk" is marked with "yes" on the basis of the resulting values, according to the applied method.

Thus, by using the Altman method, a result under 1.81 was noted in 11 firms. With the Springate method, values of Z< 0.862 were present in 21 firms. When applying the other two methods, the number of firms facing a bankruptcy risk was significantly lower. Thus, using the Poznanski method, only one of the firms was found to have a value of FD< 0.

With the Hadasik method, there were three firms whose financial state was forecast as unstable. The latter marked a value of ZHA< 0.

The used coefficients for solvency and financial sustainability also showed a higher number of firms whose financial condition was compromised.

Respectively, for ER – there were 13 firms, whose ratio of their own capital to the total asset value was less than 0.5.

The same number of firms had a ratio of their own capital to the sum of obligation less than 1. There were twelve firms with a debt coefficient DR> 0.5 and NCAFR< 1. The indicators WCAR and CR noted a complete match between the firms exceeding the threshold acceptable values, shown in Table 2, respectively- per 10 firms.

Table 3. Results – Bankruptcy risk determined by the applied methods

ALTMAN	SPRINGATE	POZNANSKI	HADASIK	ER	EDR	DR	WCAR	NCAFR	CR
no	no	no	no	no	no	no	no	no	no
no	no	no	no	no	no	no	no	no	no
no	yes	no	no	no	no	no	no	no	no
yes	yes	no	no	yes	yes	yes	yes	yes	yes
no	yes	no	no	no	no	no	no	no	no
no	yes	no	no	yes	yes	no	no	no	no
no	yes	no	no	no	no	no	no	no	no
no	no	no	yes	no	no	no	no	no	no
yes	yes	no	no	no	no	no	yes	yes	yes
no	yes	no	no	yes	yes	yes	no	no	no
yes	yes	no	no	yes	yes	yes	yes	yes	yes
no	no	no	yes	yes	yes	yes	no	no	no
yes	yes	no	no	yes	yes	yes	no	no	no
yes	yes	no	no	yes	yes	yes	yes	yes	yes
no	no	no	no	no	no	no	no	no	no
yes	yes	no	no	no	no	no	yes	yes	yes
no	no	no	no	no	no	no	no	no	no
yes	yes	no	no	yes	yes	yes	yes	yes	yes
no	no	no	no	no	no	no	no	no	no
no	yes	no	no	no	no	no	no	yes	no
no	no	no	no	no	no	no	no	no	no
yes	yes	no	no	yes	yes	yes	yes	yes	yes
no	yes	no	no	no	no	no	no	no	no
no	no	no	no	no	no	no	no	no	no
yes	yes	no	no	yes	yes	yes	no	yes	yes
no	yes	no	no	no	no	no	yes	yes	yes
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
no	no	no	no	no	no	no	no	no	no
no	yes	no	no	no	no	no	no	no	no
no	no	no	no	no	no	no	no	yes	HE
yes	yes	no	no	yes	yes	yes	yes	yes	yes
no	yes	no	no	no	no	no	no	no	no
no	no	no	no	yes	yes	yes	no	no	no
no	no	no	no	no	no	no	no	no	no

Source: own contribution.

The analysis shows that the Poznanski and Hadasik methods which were developed for firms working in Eastern Europe (Poland), are a little more lenient to enterprises that experience financial difficulties. At the same time, the western models of Altman and Springate show similar results to the methodology for financial sustainability and solvency.

Out of the analyzed companies, there was a single case of imminent bankruptcy, confirmed by all methods and indicators for financial sustainability. For confidential purposes, its name shall not be announced, but its activity will be traced for the next years to establish whether this certainty of the methods would be confirmed in time.

We believe that the applied methods of Altman and Springate may be used for bankruptcy risk analysis of Bulgarian livestock farms.

The same methods may inform about the deterioration of the firms' financial state, whereas the greater certainty of the bankruptcy prognosis may require the use of some Eastern European methods.

In order to acquire a clearer idea and to avoid listing excessive detail in the table, the information shows data for the period of one calendar year. With minute exceptions, some firms differ in the "yes" marker for bankruptcy risk, and "no" for the lack of risk throughout the years included in the observed period.

Most often, at the beginning of the studied period there is a notable risk, which diminishes with time.

In the following studies the authors will try to apply this methodology to the small firms of the same sector, and also to the large and medium-sized, despite the longer period of time.

The results from the model with fixed effects with independent variable have *ROA* been given in Table 4.

Table 4. Fixed effect results

Roa	Coef	Std. Err.	P>|z|
Salesgrowth	.06654832	.0301664	.0063581
Solvency	.0036244	.0166627	0.828
1.bankruptcy	.0569097	.0277784	0.040
subsector			
Pigs	.0195137	.0573571	0.734
Birds	.0042707	.055887	0.939
Cons	.0793853	.0585978	0.175
sigma_u	.01823924		
sigma_e	.04710842		
Rho	.13036303		

Source: Own contribution.

In the analysis of the results, it becomes evident that the bankruptcy risk is a

statistically significant indicator of the study which affects profitability. The enterprises with a high bankruptcy risk are characterized by lower total profitability of the assets, compared to firms with lower risk, evaluated by the Altman indicator. With respect to the fact that livestock farming is a sector with a low digitization degree, and the processes of digital transformation are at an early stage, we can assume that the costs for adopting a digital business model initially decrease the financial result. For a more complete study of this dependency, it would be appropriate to review it in a mid-term plan, by adding a lag variable to the model.

Unsurprisingly, the growth rate of the sales revenues has a positive, yet not very significant effect on the asset profitability.

The solvency coefficient also has a resulting negative impact on financial outcomes, however, the indicated effect is not statistically significant.

The results give a fair role to the individual characteristics of industrial enterprises. 13% of the unexplained dispersion of the return on assets is due to specific factors, originating from the separate firm.

The results from the Probit model with independent variable *Bankruptcy* have been presented in Table 5.

Table 5. Probit model results

Bankruptcy	Coef.	Std. Err.	P>z
roa	-39.67996	-2.24	0.025
digit	-685.6778	-1.71	0.087
solvency	5.715123	1.97	0.049
subsector			
DairyCattle	0		
Pigs	.8230865	0.85	0.396
Birds	0		
OtherAn	0		
_cons	-2.927963	-1.69	
/lnsig2u	-12.90745		883.4868
sigma_u	.0015746		.6955884
rho	2.48e-06		.0021906

Source: Own contribution.

The likelihood of bankruptcy is increased with the reduced profitability of assets and the lower costs incurred for intangible assets. According to the results, the enterprises with over-indebtedness show a higher probability of going bankrupt.

In the results, we also observe a negative relationship between the risk of bankruptcy and the costs of innovation and digital transformation, but it is not statistically significant. However, the obtained value of 0.087 gives us reason to assume the existence of prerequisites for the impact of innovation and digital transformation costs on the risk of bankruptcy. That is, enterprises with lower costs show a higher probability of bankruptcy.

In both of the used models, the sector, in which the enterprises operates, does not have an impact on the studied variables.

CONCLUSIONS

Agricultural enterprises face the challenge of accelerating the digital transformation of their operations, which can impact their solvency and performance. In this regard, this article compares the application of popular approaches for bankruptcy risk analysis. Using the Springgate method, compared to others, we determine the highest number of companies with an increased risk of bankruptcy (21 enterprises). The number of enterprises facing bankruptcy risk when applying the Altman method is 11. Using the following two models, a negligible number of firms face the risk of bankruptcy.

According to Hadasik's approach, an unstable financial situation is predicted for three enterprises, while according to Poznanski's method, only one company faces a risk of bankruptcy.

The solvency coefficients also show many companies with deteriorated financial health. Related to the WCAR and CR indicators, there is an even distribution between the companies that fall outside the threshold acceptable values.

The obtained results reveal that the methods of Poznanski and Hadasik show a higher tolerance towards enterprises experiencing financial difficulties. At the same time, the Western models of Altman and Springgate, as a result, are closer to the methodology for financial stability and solvency.

The econometric analysis clearly shows a statistically significant relationship between the risk of bankruptcy and the productivity of agricultural enterprises, measured by ROA. We observe a lower total return on assets for enterprises with a high bankruptcy risk, denoted by Altman's z-score. In analyzing productivity factors, we should note the relatively high significance of the enterprises' individual characteristics.

Applying the probit model reveals a higher probability of bankruptcy for firms with lower productivity and higher leverage.

Although it is not unambiguous, the obtained results give grounds for assumptions about the impact of innovation and digital transformation costs on the risk of bankruptcy.

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