Assessment of financial sustainability and risk of bankruptcy of agricultural enterprises in Bulgaria

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Abstract. The diagnostics of financial sustainability of economic subjects and the risk of bankruptcy constantly attract the attention of economists. For these purposes, a number of financial indicators have been studied and threshold values were set, above and below which the probability of bankruptcy is considered significant. The agricultural sector is an invariable field for the realization of such studies, because it is seen as highly risky due to the action of many external and internal critical factors whose influence may lead to insolvency. The present research aims to evaluate the applicability of some of the most commonly used models for analyzing financial sustainability in the agricultural sector by using financial reports over a five-year period of a representative excerpt of large and middle-sized Bulgarian firms in the agricultural sector. Crop and livestock farms have been analyzed as separate subsectors in order to determine whether the applied methods for analysis of the financial sustainability show their specifics depending on the character of their particular activity. In parallel, the authors have studied the dependency between financial health and innovative activity and proved that the higher level of digitalization presupposes better financial sustainability and reduces the risk of bankruptcy.

1 Introduction

Financial sustainability is an economic category, characterized by its multidimensionality according to the pursued aims. Numerous economists have described its nature in various research sources [1-3]. However, there is no single or commonly adopted definition for financial sustainability. Most often it is related to solvency and the ability of economic subjects to cover their debts in time, independence from external capital and achieving good financial output.

Diagnosing financial sustainability is of crucial importance for each firm because it allows prediction of an imminent risk of insolvency and bankruptcy with great precision. Therefore, the development of assessment methodologies for financial sustainability constantly engages the attention of economists, and the number of studies on reliability of such assessments continue to increase. Simultaneously, there are increasing attempts and

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claims that insist on considering the role of the sector in which the firm operates during such assessment [4]. This is explained by the fact that financial sustainability is affected by multiple factors, which are identical for all sectors, such as indebtedness level, dynamics of interest rates, etc. However, there other factors which reflect on the financial state according to the sector of operation. Agriculture is an example of a sector where factors, such as seasonality, natural disasters, etc. are specific and might lead to impairing the financial health of firms.

The study highlights the following models for predicting the deterioration of financial sustainability in agriculture in Table 1 [4-9]:

Table 1. Bankruptcy prediction models in agriculture – sources of information.

Indicators	Sources of information
Altman's model	- R. Vavrek, I. Vozarova, R. Kotulic, Evaluating the Financial Health of Agricultural Enterprises in the Conditions of the Slovak Republic Using Bankruptcy Models [4] - K. Valashkova, P. Durana, P. Adamko, J. Jaros, Financial Compass for Slovak Enterprises: Modeling Economic Stability of Agricultural Entities [5] - N. Baryshnikov, D Samygin, D Murzin. Forecasting bankruptcy models for agrarian business [6] - M. Karas, M. Režňáková, P. Pokorný, Predicting Bankruptcy of Agricultural Companies: Validating Selected Models [7] - M. S. Céu, R. M. Gaspar, Vegetative cycle and bankruptcy predictors of agricultural firms [9]
Springate's model	- N. Baryshnikov, D Samygin, D Murzin, Forecasting bankruptcy models for agrarian business [6]
IN 05	- M. Karas, M. Režňáková, P. Pokorný, Predicting Bankruptcy of Agricultural Companies: Validating Selected Models [7]
Zmijevski's model	- T. Bielikova, T. Banyiova, A. Piterkova. Bieliková T., Bányiová T., A. Piterková, Prediction Techniques of Agriculture Enterprises Failure [8] - M. S. Céu, R. M. Gaspar, Vegetative cycle and bankruptcy predictors of agricultural firms [9]

Source: Own study

Among the models, the outstanding concept of Altman is encountered in various modifications [7, 10] and is most commonly used.

2 Data and methodology

The models indicated in Table 2 are applied to the study of financial sustainability separately for firms in the crop and livestock subsectors. Each of them contains respective subindicators. On the last row of the table appears the level below or above which there might be a risk of deteriorating the financial sustainability of the enterprise and a entering a state of insolvency. The first of the models is Edward Altman's, which includes 5 (five) subindicators [4]:

$$Z = 1.2*X1 + 1.4*X2 + 3.3*X3 + 0.6*X4 + 0.999*X5 \quad (1)$$

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

Table 2. Variables included in the formulae of the models predicting financial bankruptcy in agriculture.

X	Altman	Springate	IN05	Zmijevski
X1	WK/TA	WK/TA	TA/TL	NP/TA
X2	RE/TA	EBIT/TA	EBIT/IE	TL/TA
X3	EBIT/TA	EBT/CL	EBIT/TA	CA/CL
X4	MVE/TL	S/TA	OR/TA	
X5	S/TA	-	CA/CL	
	Z<1.81	**Z<0.862**	**IN05<0.9**	**X >0**

Source: own contribution

Where:
WC – 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.
CA – Current assets.
NP – Net profit.
IE - Interest expenses.
OR – Operate revenue.

The second model is Gordon Springate's and contains 4 (four) variables [11]:

$$Z = 1.03*X1 + 3.07*X2 + 0.66*X3 + 0.4*X4 \quad (2)$$

The next model is known under the name of IN05 and also includes 5 (five) variables [12]:

$$IN05 = 0.13*TA/TL + 0.04*EBIT/IE + 3.97*EBIT/TA + 0.21*OR/TA + 0.09*CA/CL \quad (3)$$

Zmijevski Model [10]:

$$X = -4.3 - 4.5X1 + 5.7X2 - 0.004X3 \quad (4)$$

3 Results and Discussion

In the present study we have included 244 Bulgarian companies from the agricultural 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 results from the performed calculations have been summarized for the agricultural sector and in Table 3 the relative share of the enterprises in the respective subsector with precarious financial sustainability (risk of bankruptcy) is presented.

Table 3. Relative share (%) of enterprises with precarious financial sustainability.

Sector	Altman	Springate	IN05	Zmijevski
Crop production	31,90	40,60	23,20	10,10
Livestock production	24,00	44,60	28,60	4,00

Source: own calculations

The data in Table 3 shows that the most sensitive method to deterioration of financial sustainability of firms is Springate's. In both subsectors – crop and livestock production, the percentage of firms which face a risk of bankruptcy exceeds 40%. The lowest levels of sensitivity are observed in Zmijevski's method. The main reason for this is due to the selection of subindicators participating in the composition of the respective methods. Zmijevski uses mostly liquidity and leverage indicators, whereas Altman and Springate adopt solvency and profitability indicators.

Because the current assets and debts are part of the liquidity indicators, it is accepted that liquidity reflects the short-term financial sustainability of the firm, while solvency reflects the long-term financial health. In the Altman and IE 05 methods the percentage is fluctuating between 23% and 32%. Due to the limitations of the format, it is impossible to make additional investigations and compare the presented methods to the threshold values of the most commonly used indicators of financial sustainability. Perhaps this will be the focus of future research.

Next, we attempt to deepen the analysis of financial sustainability in the context of digital transformation through studying the digitalization costs of enterprises operating in the livestock sector. The total number of firms in the sector amounts to 34, as those of them which report fixed assets in the balance sheets are 20, or 67% of the entire cohort. Even though the indicated relative share may be defined as high, below we find that the value of the costs for fixed assets remains low.

The following tables present data for the enterprises which incur costs for intangible assets in their activity. We have reviewed mainly three indicators on the basis of data extracted from the balance sheets, by using mean values of the data over a five-year period – 2017-2021. The selected indicators are, as follows:

Digitalization – to measure the level of digitalization we use the ratio of intangible assets to the total asset value. The use of data from the balance sheets in this sense has been suggested in previous research [13]. Here we observe the entire size of the intangible assets, because the R&D costs in the livestock sector approach zero level.

Solvency – considering that the differences in the capital structure of enterprises is a key determinant for their ability to manage their financial sustainability, for the purposes of this research we adopt the indicator 'solvency coefficient'. To determine the solvency level, we take the ratio of the total debt sum and the own capital. This indicator is needed because literature sources have proven the dependency between capital structure and money flow of the enterprise [14], and, therefore, the possibility to attract and implement new investments (including in the process of digital transformation).

Z Altman coefficient – as a result of the above analysis we have chosen the z-score Altman model assessment to be representative for the risk of bankruptcy for the enterprises in the livestock sector. We have chosen the Altman model not only because of its wide use in literature, but because it is based on solvency and profitability indicators. Due to the specifics of the agricultural activities, it is more suitable to employ indicators for long-term financial sustainability, instead of resting on indicators characterizing short-term activity, such as liquidity and current assets. We use the obtained values for this indicator over the five-year period.

The aim of the following analysis is to investigate and offer better understanding of the level of bankruptcy risk (Z Altman coefficient), together with digitalization costs

(digitalization ratio) and solvency level (solvency ratio). The analysis of the selected indicators has been made both at the level of the livestock sector, and the subsectors – dairy cattle, pigs, poultry and other animals (apiculture).

In the following tables we analyze the main descriptive characteristics of the aforementioned indicators, which give us brief information about the mean values, the lowest and highest value and the standard deviation. The performed 89 observations include data for all enterprises over a five-year period.

From the obtained results we establish a very low mean value of the intangible assets in livestock production (Table 4). The enterprises allocate less than 1% on average of their assets to intangible asset costs, and the relative share for exclusive investment in new technologies and digital transformation is even smaller. The maximum value of the indicator at 11% we have observed in only one firm in 2019.

Table 4. Descriptive statistics of the variables: digitalization, solvency and Z Altman score.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Digitalization	89	.0066823	.0163789	.0000264	.1105045
Solvency	89	1.142231	1.962363	.0106051	12.90612
Z Altman score	89	6.154889	10.67307	-.2330275	60.48522

The high mean value of the z-score Altman model is notable. The data attest to a very good financial health of the studied enterprises from the livestock sector and a low insolvency risk. Attention must be paid to the significant dispersion of the obtained assessment of the financial sustainability around the mean which addresses possible low levels of the indicator at the subsector level.

The indicator that measures long-term solvency also changes in wide ranges from the lowest point of 0,01 to 12,9. The standard deviation shows us a very wide dispersion of the coefficient values around its mean, which requires additional analysis.

In the following tables we present a deeper distribution of the indicators for the following subsectors – dairy cattle, pigs, poultry and other animals (apiculture).

Of a total of 89 enterprises which incur expenses for new technologies and software, over 95% perform activity in the pigs and poultry subsectors. The remaining 5% are distributed between the dairy cattle and other animals (apiculture) subsectors.

As for all enterprises, we notice a low mean value of the costs for intangible assets, including new technologies – on average 0.07% of the total assets (Table 5).

Table 5. Descriptive statistics of the digitalization ratio of livestock farms.

Subsector	Mean	Std. Dev.
Dairy cattle	.00203295	.00175216
Pigs	.00659792	.02024332
Poultry	.00721741	.01476841
Other animals	.00047365	.00059638
Total	**.00668229**	**.01637893**

The highest value of the digitalization indicator is observed in the pigs and poultry subsectors. The intangible assets of these enterprises occupy on average 0.7% of all assets, whereas the results attest to value approximate to the mean for all enterprises from the two subsectors.

The highest average indebtedness and respectively, the probability for deterioration of the financial health are observed in the firms from the dairy cattle subsector (Table 6).

Table 6. Descriptive statistics of the solvency ratio of livestock farms.

Subsector	Mean	Std. Dev.
Dairy cattle	2.8050003	.40838408
Pigs	1.0173178	2.3714199
Poultry	1.1422278	1.7693512
Other animals	.52185792	.05727731
Total	**1.1422309**	**1.9623629**

It is apparent that the total level of debt of these enterprises exceeds 2.8 times their own capital and over 2 times the mean value of the coefficient for all firms (1,14). Compared to them, the solvency coefficient for the pigs and poultry enterprises is significantly lower – at 1.01 on average. The indicated value is over 2.8 times lower in comparison to the solvency coefficient of dairy cattle. The enterprises from the pigs subsector are characterized by almost equal mean values of their own and attracted capital, and also with the largest dispersion of the separate coefficients around the mean value. It is notable that in the indicated subsectors, except for 'other animals (apiculture)' the solvency coefficient shows values above 1, i.e. they are characterized with a higher value of debt against the own capital.

The obtained data for the assessment, presented through the z-score Altman model shows a high mean value of financial sustainability of enterprises operating in livestock farming (Table 7). The obtained result of 6.15 on average exceeds the reference value of 2.9, over which it is commonly accepted that enterprises fall within the secure zone.

Table 7. Descriptive statistics of the Altman's Z score of livestock farms.

Subsector	Mean	Std. Dev.
Dairy cattle	.53694681	.12852186
Pigs	11.844146	16.746574
Poultry	3.4309378	2.7554763
Other animals	2.7896131	.0866977
Total	**6.1548886**	**10.673072**

The distribution of the assessment of financial sustainability per economic subsectors shows less unambiguous results, as there is only one subsector with worse results with respect to bankruptcy risk. According to the obtained data, dairy cattle farms are characterized by a high probability for bankruptcy risk. The indicated mean assessment is less than 1.23 – a borderline value attesting to the financial distress of enterprises. The value of the standard deviation shows that the values of the separate assessments of enterprises are close to the mean for the sector. In contrast, the z-score assessment of pig farms exceeds almost twice the mean value of the total assessment for all subsector enterprises, however, it is characterized by the highest dispersion around the mean value for the sector. Concurrently, poultry farms also show high financial sustainability. It is notable that these two subsectors (pigs and poultry) are characterized with an assessment exceeding 2.9, which is a reference value above which the enterprises fall within the secure zone. It may be summarized that except for the dairy cattle subsector, all other subsectors show high financial sustainability, respectively a low bankruptcy risk.

On Figure 1 we have visualized the values of the reviewed three indicators for financial sustainability, insolvency and digitalization costs. At this stage of research, we may not affirm the presence of relations and dependencies between the used indicators. The study is rather analytical and addresses the coefficient values and their expression for the separate subsectors. As shown, the Altman z-score values change in the same direction as the values of the digitalization ratio indicator. (Figure 1)

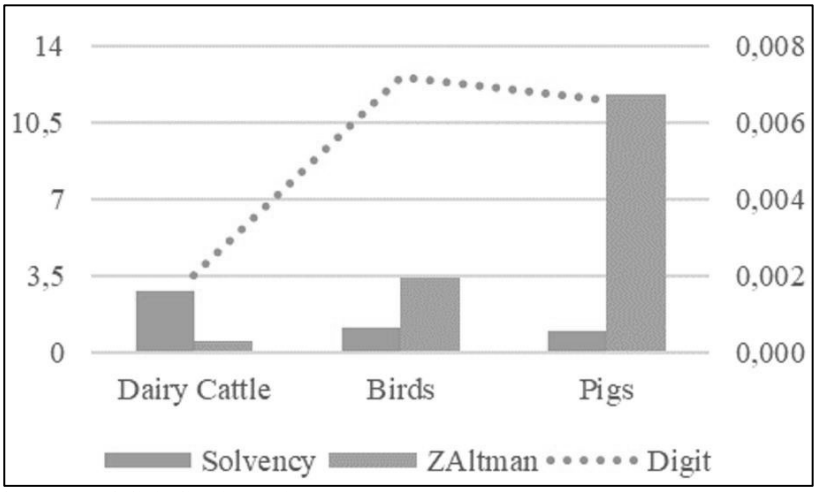

Fig 1. Bankruptcy and digitalization ratio

The pig and poultry subsectors simultaneously manifest high financial sustainability (above 2.9) and a high degree of digitalization. At the same time, we observe the lowest value of the digitalization indicator in the dairy cattle subsector, in relation to the other subsectors, which is accompanied by a higher insolvency risk. We also observe that the solvency coefficient and the values of financial sustainability indicators (Altman's z-score) and financial health change in a positive direction. The obtained result is most clearly seen in the dairy cattle subsector. It is characterized simultaneously with a high ratio of the attracted capital and respectively, a high bankruptcy risk at the lowest digitalization coefficient.

4 Conclusion

The present article directs the attention to the models of diagnosing financial sustainability in agriculture in the context of a wholesome digital transformation. The agricultural sector may be defined as strongly heterogeneous with respect to entrepreneurial work, at the background of the four subsectors of economic activity reviewed here. The mentioned heterogeneity generates the need for deeper research on insolvency risk and digitalization ratio, because a summary assessment of the entire sector would be inadequate for a given subsector. Moreover, agriculture has traditionally been seen as a sector with a high financial and credit risk and low technology sector with weak intensity of investment and innovation. In the context of the aforementioned, the level of digitalization in the sector remains at an initial stage of implementation.

In summary of the conducted research on agricultural enterprises, we may infer that a considerable part of them announce in their balance sheets investment costs with intangible assets, including costs for new technologies. At the same time, their relative share has an exceptionally low value, less than 1% of the total assets. In this framework, two subsectors stand out with a highest degree of digitalization – pigs and poultry farming. The dairy cattle enterprises are characterized with a moderate indebtedness, and respectively, a probability for deterioration of their financial health.

According to the results, at the level of all livestock enterprises, we obtained a high financial sustainability coefficient of the enterprises and a low risk of insolvency. A deeper analysis of the separate subsectors has shown a different result. Dairy cattle enterprises manifest a higher probability for bankruptcy risk, with a mean Altman coefficient lower than 1.23.

In view of the specifics of the agricultural sector, and after researching the models for financial diagnostics, we can conclude that the most sensitive to deterioration of financial sustainability is the Springate method, while the model with the lowest levels of sensitivity is Zmijevski's method.

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