Modeling the Financial Stability of Enterprises in the Third Sphere of the Agro-Industrial Complex of the Region

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Abstract. The study is devoted to the analysis of the financial stability of companies in the third sector of the agro-industrial complex (AIC) using the models of Du Pont, Altman, Lis and Sayfullin-Kadykov on the example of enterprises in the Novgorod region. Bankruptcy is a situation in which a legal entity or individual is unable to pay off its existing debt. The relevance of this topic is determined by the fact that due to the complex epidemiological situation, the threat of bankruptcy has now become a reality for a large number of companies around the world. That is why an important task is to maintain the company's solvency and strengthen its financial independence, which will ensure long-term sustainable growth of the company in the market and avoid its liquidation. To solve this problem, the authors carry out modeling of the financial stability and solvency of companies. At the end of the analysis, there are reserves for increasing and ways to improve the financial condition of companies in the third sector of the agro-industrial complex in the region.

1. Introduction

The modern agro-industrial complex (AIC) is an integral system of interconnected enterprises engaged in the production, processing and distribution of agricultural products between consumers, markets and regions. It accounts for more than 80% of all food products, which emphasizes the special place of agricultural enterprises in ensuring the growth of the nation's well-being and the economic security of the state.

Structurally, the agro-industrial complex includes three sectors:

• The first sphere is a complex of enterprises involved in the creation of means of production for agricultural producers, including agricultural construction, the production of animal feed and mineral fertilizers;

• The second sphere is the core of the agro-industrial complex, as a set of enterprises engaged in agricultural production, including two main branches of management - crop production and animal husbandry;

• The third sphere is a set of infrastructure industries that provide transportation, procurement, storage, sale and processing of agricultural products.

The object of research in this article is the third sphere of the agro-industrial complex of the region, since the quality and standard of living of the population both in individual territorial entities and in the country as a whole depend on its state and development.
2. Problem statement
Financial stability is the most important factor in their solvency and stability in the market. In the context of a dynamically changing economic environment, internal and external instability, each enterprise has the primary goal of ensuring the reliability and efficiency of its activities, which makes the problem of finding modern optimal tools for modeling the financial stability of agro-industrial enterprises urgent.

3. Research questions
- Approaches to modeling and assessing the likelihood of bankruptcy and restoration of solvency.
- Analysis of the results of solving models in relation to specific enterprises of the third sphere of the agro-industrial complex in the Novgorod region.
- Identification of reserves for increasing the solvency and growth of financial stability of agro-industrial enterprises.

4. Purpose of the study
The purpose of this article is to study the financial stability of enterprises in the third sphere of the agro-industrial complex of the Novgorod region through the consistent application of the models of Du Pont, Altman, Lis and Sayfullin-Kadykov to identify multiple factors affecting the financial condition of enterprises, assess the risks of bankruptcy, determine the reserves for the growth of financial independence and justify management decisions taken.

5. Research methods
The main principles of the process of modeling financial stability are consistency, complexity and objectivity. In theory and practice, there are two main approaches to modeling the likelihood of bankruptcy and restoration of the solvency of enterprises [1]. The first approach is based on correlating actual data on the financial condition of an enterprise with financial indicators. For this, multivariate regression models are used, which take into account changes in financial management and the economy as a whole, in capital markets and other factors. The second approach to assessing the likelihood of bankruptcy is based on comparing the data of the studied enterprise with the indicators of bankrupt companies [2].

According to the authors of this article, the first approach - building a predictive model and leveling the influence of negative factors by determining cause-and-effect relationships - is the most preferable. This is especially important in the context of an unstable external environment, a global economic recession and the widespread introduction of digital technologies [3].

The key aspect of the analysis of financial stability, and hence the competitiveness of the company, is the capital structure and its profitability, calculated on the basis of the balance sheet and the statement of financial results of the enterprise [4]. Basically, domestic and foreign models are used to assess and model the financial stability of large industrial companies that affect the development of business space, the nature, level and rate of convergence of regions [5]. Therefore, it is interesting to use the same methodological approaches in the process of modeling the financial stability of small industrial enterprises of the third sphere of the agro-industrial complex, which affect the development of society and the quality of life of the population of the region.

The theory and practice of such an analysis was laid down at the end of the 19th century by A. Marshall and was first used in practical financial analysis in the 1920s by specialists from the DuPont firm. Each modified form of the Du Pont model refines the previous one. Comparison of models helps to identify which factors have the greatest impact on the nature of financial stability [6, 7].

6. Findings
The normative value of the return on equity indicator adopted for Russian companies is in the range of 15–20%. Assessment of the return on equity of JSC (AO) Novgorodkhleb, JSC (AO) Lactis, JSC (AO)
Velikonovgorodsky Myasnoy Dvor based on the Du Pont three-factor model showed that the use of equity capital for the analyzed companies is currently not profitable.

Analysis of the results of solving the models allows us to judge that the profitability of capital of JSC Novgorodkhleb and JSC Velikonovgorodsky Myasnoy Dvor is largely influenced by the coefficients of tax and interest burden. In JSC Lactis the difference between ROA, ROE\textsubscript{1} and ROE\textsubscript{2} is always stable and ranges from 2 to 4%. Consequently, the return on equity is equally influenced by both borrowed funds and the coefficients of the tax and interest burden (table 1).

**Table 1.** Factor analysis and assessment of the return on capital use based on the DuPont five-factor model.

| Factor                  | JSC Novgorodkhleb | JSC Lactis | JSC Velikonovgorodsky Myasnoy Dvor |
|-------------------------|-------------------|------------|------------------------------------|
| \( ROE_2(y), \% \)      | 0.001             | 0.001      | 0.001                              |
| \( TB(x_4) \)           | 0.285             | 0.115      | -0.107                             |
| \( IB(x_2) \)           | 0.017             | 0.042      | -0.057                             |
| \( ROS(x_3) \)          | 0.0001            | 0.0001     | 0.0002                             |
| \( K_{oa}(x_4) \)       | 3.657             | 2.675      | 2.200                              |
| \( LR(x_5) \)           | 1.694             | 2.023      | 2.061                              |
| \( ROE_2(y), \% \)      | 8.160             | 4.301      | 2.346                              |
| \( TB(x_4) \)           | 0.787             | 0.805      | 0.735                              |
| \( IB(x_2) \)           | 0.817             | 0.744      | 0.702                              |
| \( ROS(x_3) \)          | 0.043             | 0.040      | 0.030                              |
| \( K_{oa}(x_4) \)       | 3.177             | 2.536      | 2.505                              |
| \( LR(x_5) \)           | 0.929             | 0.708      | 0.605                              |
| \( ROE_2(y), \% \)      | 8.160             | 4.301      | 2.346                              |
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| \( LR(x_5) \)           | 0.929             | 0.708      | 0.605                              |

The decision of the five-factor model makes it possible to judge that the values of the return on equity in JSC Novgorodkhleb remain stable due to a significant increase in the profitability of sales together with a decrease in the tax and interest burden ratios in 2020. In JSC Lactis, there is a steady decrease in the return on equity, which is due to a decrease in the values of all factors that have a direct impact. The situation in JSC Velikonovgorodsky Myasnoy Dvor is unstable. In 2020, the company is showing positive performance results, increasing its return on equity by more than two times. At the same time, the invested capital of the company did not bring net profit in the previous periods. Thus, in 2020, the invested capital in Novgorodkhleb JSC does not bring profit, in Lactis JSC and Myasnoy Dvor JSC 2.4% and 1.2% of the invested capital account for a ruble of profit, respectively.

Since there is a significant difference between the indicators \( ROE_1 \) and \( ROE_2 \), the influence of the interest and tax burden ratios should be studied in detail. To do this, you can use the chain substitution method (the calculation is based on the reported data in 2020, while the \( ROE_1 \) indicator is left in the base value of 2019).

Analysis of the impact of interest and tax burden indicators on the profitability of capital functioning on the basis of the Du Pont five-factor model indicates that the decrease in the return on equity in JSC
Novgorodkhleb is influenced, first of all, by a decrease in the tax burden, and in JSC Lactis - by a decrease in the tax and interest rate burden. In JSC Velikonovgorodsky Myasnoy Dvor the greatest influence was exerted by the coefficient of the interest burden.

An assessment of the presence and closeness of the relationship between factor and performance indicators showed that the degree of relationship between factors and return on equity for the analyzed companies is different. The return on equity of JSC Novgorodkhleb is primarily influenced by the percentage burden ratio and return on sales. In the other two companies, there is a close relationship between interest rate and capitalization ratios and return on equity.

Factor analysis allows us to judge that the current trend in companies may lead to negative indicators of return on equity in JSC Novgorodkhleb and JSC Lactis. At the same time, there is a positive trend in the use of equity capital in JSC Velikonovgorodsky Myasnoy Dvor. However, the return on equity model (DuPont model) cannot take into account the influence of less significant factors that affect the return on equity and the financial stability of the business.

The DuPont model has several disadvantages. For example, the use of this model does not imply dividing borrowed funds into long-term and short-term, which means that it is impossible to assess further shifts in the company's market value [8, 9].

Comprehensive objective analysis involves the use of several models, each of which contains certain values. One of these is the Altman model, which makes it possible to predict the likelihood of company bankruptcy [10]. The advantage of this model is that the five-factor model has a high accuracy in determining the probability of bankruptcy for the next year. This value fluctuates around 86-88%. However, if we take into account some of the features of Russian accounting standards and other additional factors that are unique in the Russian sector, the percentage rises to 90%. The disadvantage of this model can be considered the fact that, due to the peculiarities of the Russian economy, the final value of the Altman model may differ from reality [11].

If the Z value is less than 1.23, the company is considered to be in the financial risk zone. If the value is between 1.23 and 2.9, then it is in the zone of uncertainty. If the value of the indicator exceeds 2.9, then the company is in the zone of financial stability.

Calculations allow us to judge that JSC Lactis throughout the study period is in the zone of uncertainty. However, by the end of the analyzed period, the company approached the area of financial risk. Analysis of the values of JSC Novgorodkhleb indicates that over the three years, the company has worsened its performance, which in aggregate decreased to the level of the zone of uncertainty. The dynamics of changes in sales is great, the values of indicators are falling rapidly. JSC Velikonovgorodsky Myasnoy Dvor is confidently located in the zone of financial stability, despite the deterioration of the situation in 2020.

JSC Lactis is in the zone of financial risk. To find ways to optimize the situation, it is necessary to analyze each indicator used in the calculations of the Altman model.

The Lis model, one of the first European models, is more adaptive, since the financial coefficients are taken from the Altman model.

This method is an assessment of factors-indicators, which include such results of operations as liquidity, profitability, as well as the financial independence of the company.

One of the advantages of this model is that all indicators of economic activity are assessed in terms of asset security. Using the Lis model, specialists obtain fairly accurate results, with a probability of 80%, and the advantage of this model is the simplicity of calculations and interpretation of the results [12]. If Z< 0.037, then the probability of bankruptcy is high; if Z> 0.037, then the probability of bankruptcy is low.

The analysis showed that the probability of bankruptcy during the analyzed period for all three companies is high, since the value of all ratios is below 0.037. A more objective characterization of companies is formed by a more detailed analysis of the coefficients that are included in the Lis model and affect the final values (table 2).
Table 2. The results of assessing the likelihood of bankruptcy of companies based on the four-factor Lis model.

| Coefficient/company | JSC Lactis | JSC Novgorodkhleb | JSC Velikonovgorodsky Myasnoy Dvor |
|---------------------|------------|--------------------|-----------------------------------|
|                     |            |                    |                                   |
|                     | 2018       |                    |                                   |
| X(1)                | 0.16441    | 0.13508            | 0.10483                           |
| X(2)                | 0.15353    | 0.10532            | 0.22383                           |
| X(3)                | 0.01138    | 0.00051            | 0.09301                           |
| X(4)                | 0.17143    | 0.59022            | 0.48546                           |
| Z                   | 0.02537    | 0.01905            | 0.03318                           |
|                     | 2019       |                    |                                   |
| X(1)                | -0.05489   | 0.04590            | 0.13254                           |
| X(2)                | 0.09415    | 0.06847            | 0.13278                           |
| X(3)                | 0.00804    | 0.00033            | 0.06189                           |
| X(4)                | 0.14513    | 0.49444            | 0.56260                           |
| Z                   | 0.00999    | 0.00990            | 0.02488                           |
|                     | 2020       |                    |                                   |
| X(1)                | 0.03861    | 0.08263            | 0.21729                           |
| X(2)                | 0.07819    | 0.08811            | 0.15014                           |
| X(3)                | 0.00148    | 0.00053            | 0.05745                           |
| X(4)                | 0.13915    | 0.48513            | 0.58968                           |
| Z                   | 0.00991    | 0.01402            | 0.03160                           |

Factor analysis of the coefficients indicated that the lack of net working capital may lead to bankruptcy and liquidation of JSC Lactis and JSC Novgorodkhleb. It will be difficult for companies in the future to achieve financial stability and maintain high liquidity indicators, since net working capital is decreasing or, even worse, has reached negative values, as in the case of JSC Lactis in 2019. Changes in the situation for the better are not ensured either by our own retail network or by such a fairly effective form of doing business as franchising.

The final value of the Z-factor in the Lis model is most influenced by the profit from sales and retained earnings.

JSC Velikonovgorodsky Myasnoy Dvor has the most stable financial position among the three companies. However, an increase in the volume of retained funds and profit from sales did not allow the company to improve its financial performance. This was influenced by an increase in selling expenses by 64.51%.

An increase in companies' equity capital allows them to improve resource potential.

The analysis also revealed the shortcomings of the Lis model. For Russian companies, this model gives not entirely accurate estimates, since the profit from sales has a great influence on the final indicator, but the Lis model does not take into account the factors that affect the profit.

The Sayfullin-Kadykov model is adapted for Russian conditions and is a bankruptcy risk forecasting model that can be applied to any industry and enterprises of various sizes (table 3). However, it should be noted that this is a simplified model that does not take into account industry specifics. Taking into account a larger number of factors, the result may turn out differently, a deeper analysis is required.

The Sayfullin-Kadykov model confirms the conclusions formulated during the construction of the previous models: JSC Lactis is in the highest risk of bankruptcy, JSC Novgorodkhleb has an unstable position, JSC Velikonovgorodsky Myasnoy Dvor has an acceptable indicator above 1, which indicates a low probability of bankruptcy.

The Saifullin-Kadykov bankruptcy model made it possible to identify the main problem of the existing bankruptcy risk for two, at first glance, financially sound companies. The low value of equity capital entails an increase in the dependence of companies on borrowed funds. The growth of borrowed
funds and accounts payable indicates a worsening financial situation.

Table 3. Analysis and assessment of the probability of bankruptcy of the company based on the Sayfullin-Kadykov model.

| Coef. | Value for 31.12.2018 | Value for 31.12.2019 | Value for 31.12.2020 | Factor | 2018 | 2019 | 2020 |
|-------|----------------------|----------------------|----------------------|--------|------|------|------|
|       | JSC Lactis           |                      |                      |        |      |      |      |
| K₁    | -1.07                | -1.32                | -1.30                | 2.00   | -2.14| -2.64| -2.59|
| K₂    | 1.71                 | 0.87                 | 1.13                 | 0.10   | 0.17 | 0.09 | 0.11 |
| K₃    | 1.77                 | 1.67                 | 1.78                 | 0.08   | 0.14 | 0.13 | 0.14 |
| K₄    | 0.09                 | 0.06                 | 0.05                 | 0.45   | 0.04 | 0.03 | 0.02 |
| K₅    | 0.08                 | 0.06                 | 0.01                 | 1.00   | 0.08 | 0.06 | 0.01 |
| Total (R): |                  |                      |                      | -1.17  | -2.33| -2.31|      |
|       | JSC Velikonovgorodsky Myasnoy Dvor |              |                      |        |      |      |      |
| K₁    | 0.13                 | 0.17                 | 0.22                 | 2.00   | 0.26 | 0.34 | 0.44 |
| K₂    | 1.16                 | 1.21                 | 1.41                 | 0.10   | 0.12 | 0.12 | 0.14 |
| K₃    | 4.15                 | 4.63                 | 4.44                 | 0.08   | 0.33 | 0.37 | 0.36 |
| K₄    | 0.05                 | 0.03                 | 0.04                 | 0.45   | 0.02 | 0.01 | 0.02 |
| K₅    | 0.29                 | 0.17                 | 0.15                 | 1.00   | 0.29 | 0.17 | 0.15 |
| Total (R): |                  |                      |                      | 1.02   | 1.01 | 1.11 |      |
|       | JSC Novgorodkhleb    |                      |                      |        |      |      |      |
| K₁    | -0.02                | -0.49                | -0.27                | 2.00   | -0.04| -0.98| -0.55|
| K₂    | 1.33                 | 1.16                 | 1.19                 | 0.10   | 0.13 | 0.11 | 0.12 |
| K₃    | 3.66                 | 2.67                 | 2.20                 | 0.08   | 0.29 | 0.21 | 0.18 |
| K₄    | 0.03                 | 0.03                 | 0.04                 | 0.45   | 0.02 | 0.01 | 0.02 |
| K₅    | <0.01                | <0.01                | <0.01                | 1.00   | <0.01| <0.01| <0.01|
| Total (R): |                  |                      |                      | 0.41   | -0.65| -0.23|      |

In order to identify the possibility of companies to restore or lose their solvency in the next six months, it is necessary to calculate the coefficient of restoring solvency.

Calculation of the solvency recovery ratio showed that each of the analyzed companies has no reserves for improving solvency in the next six months.

7. Conclusion

Ensuring financial stability in modern economic conditions is the main task of agricultural organizations and a topical topic of scientific discussions. The ongoing economic crisis increases the risks of bankruptcy of enterprises in the third sector of the agro-industrial complex. One of the possible solutions to this problem can be an import substitution strategy based on the production of competitive agricultural products. In order to create competitive products, an agricultural producer must have good indicators of the economic efficiency of its activities, be liquid, solvent and financially stable. Consequently, the development of methods and models for assessing the financial stability of agricultural enterprises and their testing in practice is an integral element of the system of stabilization and development of agricultural production.

The currently existing models and methodological approaches to assessing the financial stability and the likelihood of bankruptcy of enterprises (the models of Du Pont, Altman, Lis and Sayfullin-Kadykov) make it possible to comprehensively study the parameters of solvency and stability of agricultural production, as well as form information support for managing financial stability and minimizing existing risks.

Comprehensive and systematic analysis of assessing the likelihood of bankruptcy of companies in the third sector of the agro-industrial complex and modeling of financial stability, allow to establish objectively existing causal relationships between effective indicators and factors that generate them.
identify multiple reserves and justify ways to improve processes, form a representative information base for making management decisions.

References

[1] Taranova I, Podkolzina I, Uzdenova F, Dubskaya O and Temirkanova A 2021 Methodology for Assessing Bankruptcy Risks and Financial Sustainability Management in Regional Agricultural Organizations *The Challenge of Sustainability in Agricultural Systems* 239–245 DOI: 10.1007/978-3-030-72110-7_24

[2] Nyitrai T 2019 Dynamization of bankruptcy models via indicator variables *Benchmarking: An International Journal* 26 DOI: 10.1108/BIJ-03-2017-0052

[3] Kivarina M, Afanasyeva T and Yurina N 2021 Problems in the development of digitalization of Russia's agriculture *IOP Conference Series: Earth and Environmental Science* 699 (1) 012005 DOI: 10.1088/1755-1315/699/1/012005

[4] Albanese C, Crépey S, Hoskinson R and Saadeddine B 2020 XVA analysis from the balance sheet *Quantitative Finance* 21 1–25 DOI: 10.1080/14697688.2020.1817533

[5] Chebotareva G, Strielkowski W and Gafurov N 2020 Applicability of Forecasted Bankruptcy Models to Russian Industrial Companies *Bulletin SUSU MMCS* 13 98–102 DOI: 10.14529/mmp200311

[6] Vavrek R, Gundová P and Marchevska M 2019 Statistical Verification of Selected Bankruptcy Models – Case Study *Journal of Applied Economic Sciences* XIV 9–20 DOI: 10.14505/jaes.v14.1(63).01

[7] Fedorova E and Dovzhenko S 2015 The model of bankruptcy forecasting the construction industry and agriculture. *Effective Crisis Management* 6 94–99 DOI: 10.17747/2078-8886-2014-6-94-99.

[8] Mityushina I 2019 Factor analysis of profitability based on dupont models and their practical application *Balkan Scientific Review* 3 96–98 DOI: 10.34671/SCH.BSR.2019.0304.0022.

[9] Balezentis T and Novickyte L 2018 Are Lithuanian Family Farms Profitable and Financially Sustainable? Evidence Using DuPont Model, Sustainable Growth Paradigm and Index Decomposition Analysis *Transformations in Business and Economics* 17 237–254

[10] Najib A and Cahyaningdyah D 2020 Analysis of The Bankruptcy of Companies with Altman Model and Ohlson Model *Management Analysis Journal* 9 243–251 DOI: 10.15294/maj.v9i3.37797

[11] Vavrek R, Gundová P, Kravčáková V and Kotulič R 2021 Altman Model Verification Using a Multi-Criteria Approach for Slovakian Agricultural Enterprises *Ekonomie a Management* 24 146–164 DOI: 10.15240/tul/001/2021-1-010

[12] Viciwati V 2020 Bankruptcy prediction analysis using the Zmijewski model (X-Score) and the Altman model (Z-Score) *Dinasti International Journal of Economics, Finance & Accounting* 1 794–806 DOI: 10.38035/dijefa.v1i5.608