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Should more sustainable companies be more efficient?*

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Abstract

This study is devoted to the analysis of the relationship between the solution of two different tasks facing the management of a commercial organization - ensuring the efficiency and sustainability of the business. An analysis of publications on this topic shows the existence of contradictory conclusions.

This study uses the author's approach to determining and evaluating efficiency, presented in [15, 16, 17, 18], which is a generalization of the established practice of evaluating effectiveness using Data Envelopment Analysis (DEA). The corresponding indicator was obtained as a result of a multi-criteria analysis and was named overall effectiveness.

The empirical part of the study was performed on the data of the annual financial statements of Russian food industry enterprises for 2021-2023. Unprofitable companies, companies that were formed or liquidated during this period of time, as well as those companies whose reporting did not allow evaluating efficiency, were excluded.

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Modeling using linear regression for panel data allowed us to conclude that there is a statistically significant relationship and its pronounced industry specifics. The authors concluded that there might be a non-linear relationship between capital structure and overall efficiency.

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Keywords: overall efficiency; efficiency; sustainability; multi-criteria analysis; data envelopment analysis; principal component analysis; food production

1. Introduction. Theoretical foundations of the study

The task of business performance assessment is one of the most important tasks in the strategic management. Comprehensive review of possible solutions may be found in the [20]. Authors state that performance assessment implies an assessment of financial and market performance, as well as total shareholder return. This study is aimed at developing methods for financial efficiency assessment and the analysis of its relationship with ensuring the financial sustainability of the business. Study was done on the accounting data of Russian companies during the period of increased sanctions pressure in 2021 – 2023 years.

There are many methods for evaluating financial performance that can be based on accounting statements or financial market data. There is no doubt that the second option is the most attractive, as it allows the appraiser to look into the future of the business. Unfortunately, not all companies are visible to the financial markets and receive their assessment of their activities. It's just the case of most Russian companies which do not attract portfolio investments on stock exchanges (except for issuing bonds in rare cases) and finance their activities mainly with their own funds, funds from direct investors and short- and long-term loans. Thus, the only way to assess the business performance of most Russian companies is to use metrics based on accounting statements. In this research accounting-based metrics were used.

In addition to the data source, business performance assessment metrics vary significantly in their meaning. They evaluate different business properties. In the current study, the indicators that are closest to the concept of efficiency were used. As a rule, the degree of efficiency of any type of activity is assessed by the ratio of the volume of the result and the amount of each of resources used. Thus, this study uses financial performance indicators similar in meaning to ROA, ROE, etc. The differences determine the types of resources consumed in the production process. The main issue when using indicators such as return on investment (ROI) is related to the methods of their calculation. They are usually based only on the accounting data of the company being evaluated and don't take into account results of other companies, that is, the limit of production capabilities. It is a widespread practice to set industry standards for the values of such indicators to solve this problem. However, in our opinion, industry standards do not accurately reflect the specific characteristics of market participants and provide a very rough comparison of their efficiency. We will refer to such metrics as stand-alone performance assessments and do not recommend using them in practice.

There is a well-known company performance assessment solution based on comparing the results of a pre-selected group of organizations, which was introduced in Farrell's early work in the mid-50s of the 20th century [9] and became widespread in the late 20th and early 21st centuries [3, 4, 6]. The idea of this solution — to evaluate efficiency as the distance to the limit of production capabilities (production frontier) in the chosen direction — has received two implementations. The first one is Data Envelopment Analysis (DEA) is grounded on the linear programming and non-parametric model of frontier [8]. The second one — Stochastic Frontier Analysis (SFA) utilize parametric model of production frontier [1]. In this study, we use the first of these approaches due to the lack of the need to specify a parametric model of the production frontier and the widespread use of DEA in benchmarking, which is an adequate area of application of our results. We will refer to such indicators as comparative estimates of efficiency, and this study is aimed at extracting the maximum amount of information from them.

There can be two points of view on evaluating effectiveness [21]. One can compare the consumption of amount of a selected set of resources for the production of a fixed volume of products. In this case, the most effective company will be the one that was able to maximize savings of the selected set of resources during the production of a fixed volume of products. We will refer to this type of efficiency as saving efficiency. Alternatively, one can record the consumption of a certain set of resources and compare production volumes. In this case, the most effective company

will be the one that was able to produce the maximum while consuming a fixed amount of a selected set of resources. We will refer to this type of efficiency as production efficiency. This study uses saving efficiency because this type of efficiency is more adequate to the conditions of sanctions pressure on business.
And finally, we should mention that comparative estimates of efficiency in the form of saving efficiency may take or not take into account return on scale for companies to be compared. When using the second type of estimates, it is assumed that all companies have an optimal scale of activity. This assumption is inadequate for the heterogeneous conditions in which Russian companies operate. Thus, in the current study the comparative estimates of efficiency in the form of saving efficiency with variable returns to scale is used [4].
There is a lot of uncertainty when using comparative performance estimates, regardless of the calculation approach. The appraiser must determine the set of products produced (the company's output) and the set of resources consumed in the production process (the company's costs). The composition of these kits (also known as the performance model specification) is completely free in choice and depends on the opinion of the evaluator. Comparative performance estimates can vary significantly depending on the choice of input and output data. We should refer to various kinds of comparative performance estimates as partial efficiency estimates.
Appraiser meet the problem of multi-criteria analysis (MCA) of companies. There is large amount of publication in concern of methodology of MCA [2, 13, 24, 11]. Many authors recommend to use Principal Component Analysis (PCA) for criteria aggregation. This idea was used by the authors of this study to form a methodology for calculating the overall efficiency indicator based on partial efficiency indicators [15, 16, 17, 18].
Following this methodology, it is, first, necessary to determine the composition of possible inputs and outputs for a pre-selected set of companies and calculate the partial efficiencies for all possible DEA specifications as it was described above. Next, it is necessary to do Principal Component Analysis of the obtained set of vectors of partial efficiencies and select the first few Principal Components for further use. We refer to the first of them as indicator of overall efficiency. As a rule, all its' factor loadings positive and overall efficiency increase in common with increase of any partial efficiency indicator.
Second and other Principal Components are of great importance. Analysis of their factor loadings give appraiser ability to reveal the sources of achieving the existing level of overall efficiency for each company and to group companies according to strategies for managing overall efficiency. Thus, the methodology proposed by the authors allows the appraiser to determine how efficient the activities of each company are from a pre-selected set and determine the way to achieve the current level of efficiency.
The task of evaluating financial performance is an important task of strategic management, but not the only one. An equally important task is to assess and manage the financial sustainability of the company. Financial sustainability is equal wide concept as business performance [19] and its discussion goes far beyond the scope of this publication. There are a lot of publications in concern with financial sustainability measurement and management. Deep sight in tis area may be found in the work [10]. Authors define financial sustainability as combination of four qualities: the company's growth exceeds the growth of inflation, probability to survive is high enough, acceptable total earnings risk exposure and the owners are interested in the long-term development of the company.
It is obvious that the tasks of efficiency management and sustainability management are different tasks that need to be solved simultaneously. Thus, it's extremely important to understand interaction of these tweo management processes. There is rich bibliography in concern with this problem [7, 22, 12]. And there is not unique opinion should more sustainable companies be more efficient. Current study tries to give answer on this question.

2. The empirical part of the study

2.1. Description of the data

The annual financial statements of companies related to the Food Production industry (OKVED 2 code 10) are used in the empirical part of the study. The choice of this industry is determined by its importance to the end user during a period of growing economic turbulence, when rising inflation significantly reduces the purchasing power of the population and limits the ability of manufacturers to supply high-quality food to the market. Sample set include data from "Balance Sheet", "Income Statement" and "Cash Flow Statement" for 2021 – 2023 years. The year 2022 is known for a sharp increase in sanctions pressure on the Russian economy. The previous and subsequent years are included in the analyzed time interval for comparison. These data were used to calculate overall performance and financial sustainability indicators for each year.
In accordance with the calculation methodology developed by the authors for overall efficiency assessment, the composition of consumed resources (potential inputs of partial efficiency models) and manufactured products (potential outputs) was determined. The set of inputs included the balance sheet values of revenue and personnel

costs at the end of each year, as well as the average size of current and non-current assets, as the arithmetic average of these values on the balance sheet at the beginning and end of each year. The set of outputs consisted of one element - profit before taxes.
The composition and methodology for calculating indicators characterizing financial sustainability are shown in Table 1.

Table 1. Characteristics of capital structure, liquidity and sustainability

№	Indicator name	Variable in model	The calculation formula for the balance sheet lines
	Liquidity		
1	Absolute liquidity	abs_liq	«1250» / «1510+1520»
2	Fast liquidity	fst_liq	«1230+1240+1250» / «1500-1530»
3	Current liquidity	cur_rat	«1200» / «1510+1520»
9	The coefficient of availability of own working capital	pwc	«1300 – 1100» / «1200»
	Structure of liabilities		
4	The coefficient of autonomy (The share of equity in liabilities)	atn	«1300» / «1600»
5	Share of short-term liabilities in liabilities	stdr	«1500» / «1700»
	Financial sustainability		
6	Financing ratio	fin	«1300» / «1400+1510 +1520+1550»
8	The coefficient of mobility	mob	«1300 – 1100» / «1300»

The original sample has been reduced. First of all, unprofitable companies were removed. Secondly, we exclude companies that were liquidated or formed between 2021 and 2022. And finally, companies for which it was impossible to calculate partial efficiencies and financial stability indicators were excluded too. The industry structure of the sample obtained is shown in Fig. 1.

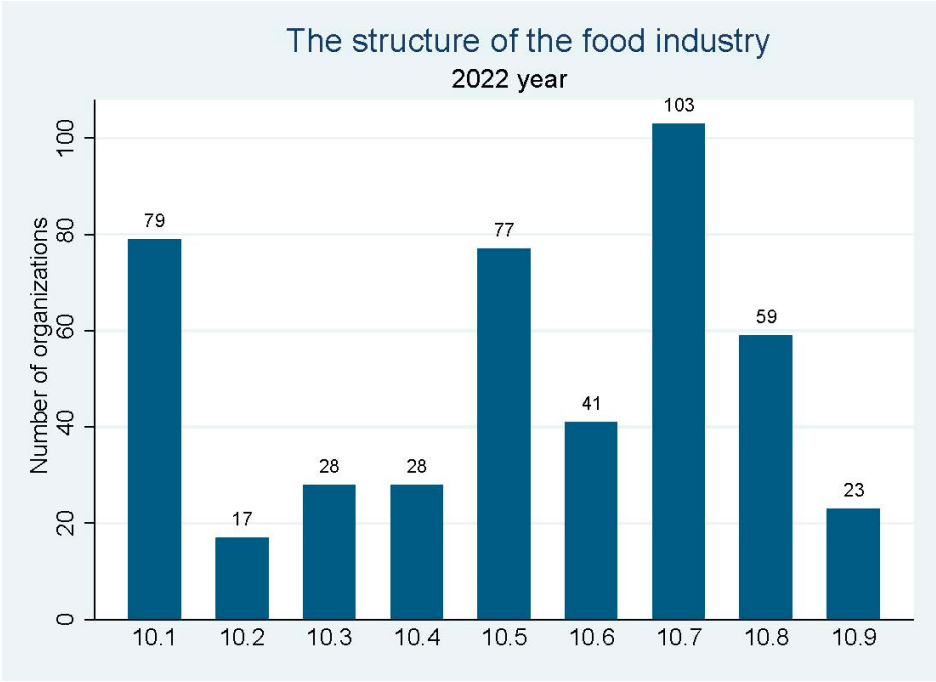

Fig. 1. Sample set of companies after reduction. OKVED 2 codes were used.

2.2. Results of the overall effectiveness assessment

In accordance with the above methodology, a list of resources (potential inputs) was generated. It includes revenue, personnel costs, and the book value of current and non-current assets. The pre-tax profit was used as the manufactured product (the output indicator in the performance model specification). Thus, 15 specifications of partial efficiency models, i.e., models for Data Envelopment Analysis, were obtained. As a result, for each year 15 partial efficiency options were calculated for all companies in the industry.

Further, the Principal Components Analysis was performed for each year. The results were quite similar. Based on the analysis of the scree plot for each year, the first two principal components were selected for further use. All factor loadings of the first Principal Component were positive and we interpreted it as an indicator of overall efficiency. The value of this indicator increases with the growth of any partial efficiency. The second one gives us ability to discover sources of efficiency for each company in the dataset.

Fig. 2 shows the results of calculations of the overall efficiency. The values of the overall efficiency are plotted along the X-axis, and the values of the second Principal Component are plotted along the Y-axis. The analysis of its factor loadings allows companies to be divided by sources of efficiency. They are indicated in the comments in the Fig. 2.

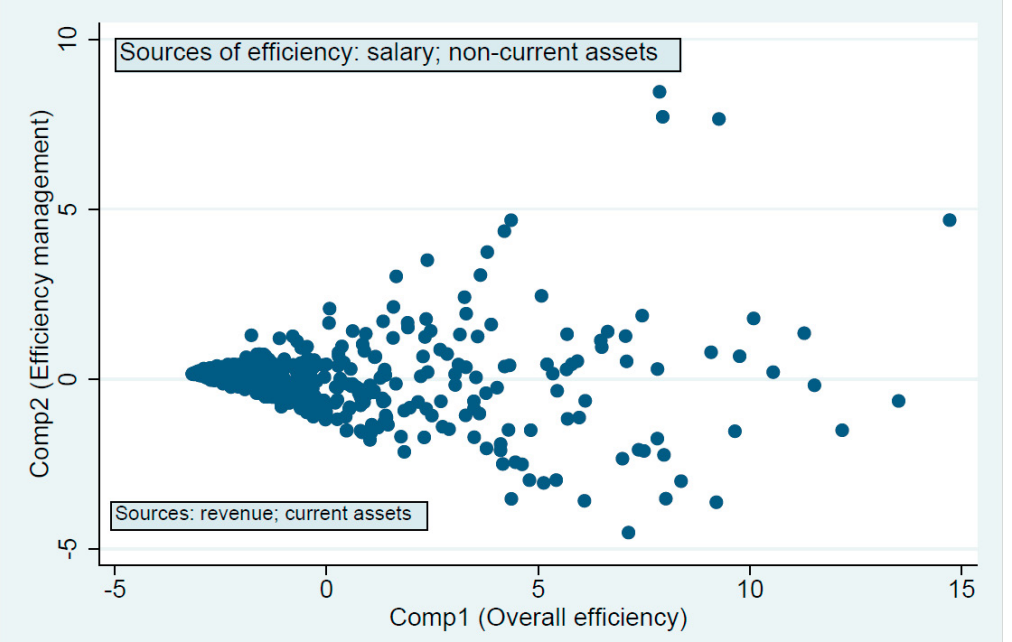

Fig. 2. Results of overall efficiency estimation for 2022 year.
Negative values of the second Principal Component correspond to the effective use of revenue and current assets. Its positive values correspond to the effective use of personnel and non-current assets.

2.3. The results of the assessment of the relationship between sustainability and overall effectiveness

Because of our calculations, we have obtained panel data that characterize the overall efficiency and sustainability of Russian food industry enterprises over three years. To account for industry specific, dummy variables for sub-sectors were additionally included in the number of variables — br110_1, br10_2, …, br10_9.

Thus, to analyze the relationship we are interested in, we used panel data linear regression with a random effect. The overall efficiency score is used as the target variable. This is an uncontested choice, since the explanatory variables include dummy variables that do not change over time. Dependent variable (overall efficiency) is calculated with a one-year lead-time. In this regard, there are no problems related to endogeneity.

We used several model estimations options in order to take into account the possible heteroscedasticity of the random component and analyze the stability of the significance assessment. In all cases, we are talking about a method for estimating the covariance matrix of estimates of model parameters. In addition to the traditional assessment (oim), we used robust assessment [23], as well as assessments based on bootstrap and jackknife technologies [5, 14]. We also optimized the estimated model, step-by-step removing the least significant indicators (in the sense of robust significance estimation) and re-evaluating the model until only significant indicators remained in the model. Table 2 shows the evaluation results.

Table 2. The results of the assessment of the relationship between financial stability and overall efficiency. Standard errors in parentheses. * — p<0.05; ** — p<0.01; *** — p<0,001

regressors	A way to assess significance			
	oim	robust	bootstrap	jackknife
br10_8	1,156**	1,156**	1,156**	1,156**
	(0,379)	(0,393)	(0,441)	(0,399)
br10_9	1,722**	1,722**	1,722**	1,722*
	(0,583)	(0,649)	(0,635)	(0,677)
atn	1,235***	1,235**	1,235**	1,235*
	(0,312)	(0,417)	(0,412)	(0,494)

fin	-0,00591**	-0,00591***	-0,00591	-0,00591
	(0,00182)	(0,00107)	(0,00502)	(0,0077)
fst_liq	0,00825**	0,00825***	0,00825	0,00825
	(0,00266)	(0,00153)	(0,00709)	(0,0104)
_cons	-0,769***	-0,769***	-0,769***	-0,769**
	(0,194)	(0,232)	(0,228)	(0,262)
sigma_u	2,429***	2,429***	2,429***	2,429***
	(0,102)	(0,17)	(0,152)	(0,176)
sigma_e	2,064***	2,064***	2,064***	2,064***
	(0,0485)	(0,116)	(0,125)	(0,116)

It can be seen that all estimates are significant, but this result is not stable for all indicators.

3. Brief conclusions

This study uses a new approach to defining and evaluating the efficiency of an organization, which summarizes traditional performance assessments based on Data Envelopment Analysis. The overall efficiency indicator introduced by the authors characterizes the quality of the implementation of the main business process that consumes a selected set of resources and produces a selected set of products. The proposed approach gives the ability to conduct a comparative analysis of the efficiency of Russian food industry enterprises, to identify leaders and laggards according to the criteria of profitability of various types of resources consumed.

The author's methodology made it possible to divide companies into two categories. Representatives of the former efficiently use their staff and non-current assets. Representatives of the second category demonstrate high profitability of revenue and current assets.

The main result of the study is the result of an analysis of the relationship between the overall efficiency and financial sustainability of organizations in the chosen industry. Calculations show that the coefficient of autonomy has a consistently significant positive relationship with overall efficiency. At the same time, the funding ratio has a significant negative statistical relationship with overall efficiency. However, the significance of this relationship is unstable and sensitive to the composition of the data. When using bootstrap and jackknife ratings, it is not significant.

The seemingly contradictory situation speaks to the nonlinear nature of the relationship between capital structure and overall efficiency. Simple algebraic calculations that take into account the meaning of these indicators allow us to conclude that if the amount of equity significantly exceeds the amount of borrowed capital, then the combined impact of these indicators on overall efficiency will be negative. Thus, it can be assumed that there is an optimal ratio of equity and debt capital, in which the growth of equity capital will ensure an increase in overall efficiency. Focusing solely on the growth of financial sustainability solely due to the growth of own funds will lead to a decrease in efficiency.

At the same time, rapid liquidity, i.e. the share of highly liquid assets in their total volume, is positively associated with overall efficiency. However, the significance of this relationship is unstable. It can be assumed that in the food industry, high solvency makes it possible to quickly repay short-term loans of resources needed for the production process.

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