Polyakov Konstantin
National Research University Higher School of Economics,
20, Myasnitskaya str., Moscow, 101000,
Russian Federation
polyakov.kl@hse.ru

Polyakova Marina
National Research University Higher School of Economics,
20, Myasnitskaya str., Moscow, 101000,
Russian Federation
mpolyakova@hse.ru

DYNAMICS OF THE EFFICIENCY OF PRODUCTION COMPANIES DURING THE SANCTIONS PERIOD IN THE SECTORAL CONTEXT[1]

Abstract. This study is devoted to the analysis of the quality of financial management in manufacturing companies. This characteristic of an organization can have a significant impact on the assessments of its investment attractiveness and development prospects. Despite the importance of this task, there is no formalized approach to solving it generally accepted in all industries. A financial management quality assessment tool based on efficiency analysis using data envelopment analysis (DEA) is proposed. DEA has been successfully used to solve a similar problem in the financial sector within the framework of the CAMELS system. Taking it as a basis we supplement it with a number of technical elements that allow solving a number of methodological problems, in particular, comparing the most effective organizations and analyzing sources of efficiency. The results of testing the proposed financial management quality assessment tool on financial sector firms are presented in previous publications of authors. In the study this approach was used to compare manufacturing companies on the eve and immediately after the aggravation of the geopolitical situation.

Keywords: financial management; technical efficiency; data envelopment analysis; principal component analysis; overall efficiency

Polyakov Konstantin
National Research University Higher School of Economics,
20, Myasnitskaya str., Moscow, 101000,
Russian Federation
polyakov.kl@hse.ru

[1] The research was carried out within the framework of the HSE Fundamental Research Program with the support of the Laboratory of Financial Innovation and Risk Management, as well as the Laboratory of Competition and Antimonopoly Policy of the National Research University Higher School of Economics

Polyakova Marina
National Research University Higher School of Economics,
20, Myasnitskaya str., Moscow, 101000,
Russian Federation
mpolyakova@hse.ru

Introduction

The task of assessing management quality does not have a generally accepted formalized solution for all market sectors. At the end of the last century, an approach to solving it was proposed for the financial segment of the economy, which found support among practitioners and is still used today. It is closely related to the CAMELS technology for assessing the sustainability of credit institutions, which uses a management quality indicator to rate banks. The solution to the problem of assessing the value is proposed in [Siems, 1992] and is based on evaluating of organization efficiency using data envelopment analysis.

Let's briefly focus on the idea of using the concept of "efficiency" to assess the quality of management. It is assumed that there are a number of implementations of some business process, where the concept of "process" is defined in accordance with GOST R ISO 9000-2001 as "a set of interrelated or interacting activities that transform inputs into outputs." The interpretation of the meaning of inputs and outputs can be as broad as possible. It is also assumed that the goals of implementation management coincide.

Since we are talking about the same business process, the composition of both consumed resources and created outputs are the identical in all cases. Also, there is no doubt that the proportion of inputs and outputs will vary from one implementation to another. If the

management goals coincide, the differences will be primarily due to its quality.

At the same time, efficiency is usually understood as the ratio of the observed values of certain indicators related to resources and/or products to their best (optimal) values in a certain sense for a certain set of implementations of a particular process. Thus, an efficiency assessment is an adequate assessment of the quality of management.

The interpretation of efficiency depends on the management objectives. Accordingly [Pindyck, Rubinfeld, 2018], the concepts of "input efficiency" arise when output volumes are fixed and consumption volumes of resources for their production are analyzed. "Output efficiency" appears when resource consumption volumes are fixed and output volumes are analyzed.

Traditionally, entities that provide various implementations of the selected process are called Decision Making Units (DMUs). They get the same sets of m-types of resources (x, inputs) and produce the same sets of s-types of products (y, outputs).

There are two main approaches to evaluating the effectiveness of implementation. One of them is the Stochastic Frontier Analysis (SFA) method. It is a variant of regression analysis [Aigner, Lovell et al, 1977; Kumbhakar, Lovell, 2003] and requires to specify a production function. Another problem is the difficulty of extending this approach to the case when DMUs produce several products, i.e. have a vector output [Kumbhakar, Lovell, 2003]. The second approach – Data Envelopment Analysis, DEA – is based on linear programming [Charnes, Cooper et al 1978; Charnes, Cooper, Seiford, 2007]. It is devoid of SFA disadvantages and it served as the basis for the formation of a financial management quality assessment tool.

The efficiency of each DMU should be defined as the distance to the boundary of a given set of production capabilities. In [Charnes, Cooper et al 1994; Cooper et al 1994; Cooper, Seiford et al, 2004; Cooper, Seiford, 2007] a linear programming was proposed to solve the problem. The corresponding assessment was called CCR. An important development of the above method was the assessment of weak efficiency formulated in [Banker, 1984] and called BCC. Its' technical difference from the CCR assessment is in the presence of an additional constraint in the corresponding linear programming problem, which ensures the convexity of set of production capabilities.

In the current study, we estimate efficiency according to the model BCC. This choice is guided by the fact that the external economic environment in which Russian production companies operate is very heterogeneous and determines the different returns on scale. Thus, the most appropriate assessment option would be the BCC assessment. Choosing the orientation of efficiency assessment, the authors proceeded from the assumption that nowadays the production companies is focused on maximization of results while preserving available resources to compensate for the lack of imported goods.

Methods and materials

There are a number of reasons that make it necessary to refine and develop the idea of using the DEA assessment of technical efficiency to assess the quality of management.

The obvious problem with this approach is the lack of a formal procedure for choosing the composition of "inputs" and "outputs". The many different options reflect many interpretations of the quality of management. The specific choice depends on the needs of the appraiser. For a fixed set of DMUs, the results of the technical efficiency

assessment may differ significantly for different selections of the composition of the "inputs" and "outputs" — a partial DEA model. Organizations that are most efficient for one model may have extremely low efficiency for another.

Also, for each partial DEA model, there may be a situation where a whole group of DMUs has full technical efficiency (equal to one), each element of which has a unique strategy for achieving it. In [Banker, Chang, 2006], the need for a tool to compare fully efficient organizations was noted.

A solution to these problems was proposed in [Polyakov, Polyakova et al., 2022; Polyakov, Polyakova, 2023]. It is based on the use of the principal component analysis. In particular, based on real data, it is shown that the first principal component of the set of possible DEA efficiency estimates increases with the growth of the evaluation of any variant of a partial assessment. Thus, it can act as an indicator of overall efficiency (as opposed to an indicator of partial efficiency for a specific DEA model), which allows you to compare the quality of management of organizations, even if they have the maximum values of some partial efficiency estimates.

This methodology also allows you to analyze the sources of high or low efficiency of individual organizations based on the analysis of the values of the other principal components, which also have an applied meaning.

In accordance with the above methodology, we selected the following composition of potential inputs of the DEA model: revenue volume (profit and loss statement); non-current assets (balance sheet); current assets (balance sheet); labor payment (cash flow statement).

As the only way out, it was considered: profit (loss) before taxation (balance sheet).

This choice made it possible to form set of specifications of partial DEA models, which used various combinations of inputs.

As an empirical base in the proposed study, financial reporting data from the SPARK — information and analytical system of the Interfax news agency were used. Production companies were selected based on OKVED 2 codes. The years 2021, 2022 and 2023 were chosen as being directly close to the time of the aggravation of the geopolitical situation.

The resulting sample has undergone a significant reduction. In the final training set, companies were selected that functioned at the selected time interval and had strictly positive input and output values.

Results

The resulting production set included 2,888 companies from 24 manufacturing industries in accordance with the two-letter OKVED 2 codes. However, the majority is too small for statistical analysis. Some industries are heterogeneous and require the use of four-letter codes for analysis. We present the results for relatively homogeneous and well-represented industries: 10 — food production (527 organizations); 20 — production of chemicals and chemical products (101 companies); 22 — production of rubber and plastic products (249 companies); 26 — production of computers, electronic and optical products (110 companies); 27 — production of electrical equipment (118 companies); 0 — companies not included in this list.

Let's consider the results presented in the form of classified Box-Whisker charts by industry and time (Fig. 1). For clarity, outliers have been excluded from the graphs. Thus, it is possible to form an opinion

about quality of financial management for the average 50% of representatives of each industry.

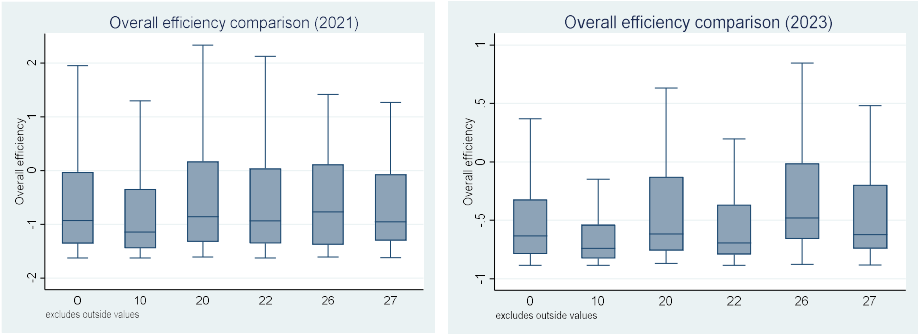

Fig. 1. Comparison of the overall performance of selected industries.

First, note that by definition, the principal components are centered and the value 0 corresponds to the average value for the production possibility set. Thus, it can be concluded that over the selected period of time, the quality of financial management in almost 75% of representatives of each selected industry decreased in relation to the average value for the entire set. Moreover, in each industry, about 25% of companies, let's call them "leaders", have significantly improved this indicator. The graphs clearly show an increasing gap in values of the overall efficiency between the "leaders" and the bulk of the industry participants. A similar situation is observed for the aggregate mass of other companies. In the sectoral context, the ratio of median values of the quality of financial management is maintained from year to year. It is explained by the constant heterogeneity of working conditions in industry markets. In particular, the higher cost of resources consumed leads to a higher cost of outputs, which requires more qualified financial management to maximize profits. Also, a higher level of competition,

primarily with similar imported goods, requires a higher level of overall efficiency.

Let us trace the dynamics of the quality of financial management for selected industries. Consider food production (Fig. 2). The rest have similar dynamics.

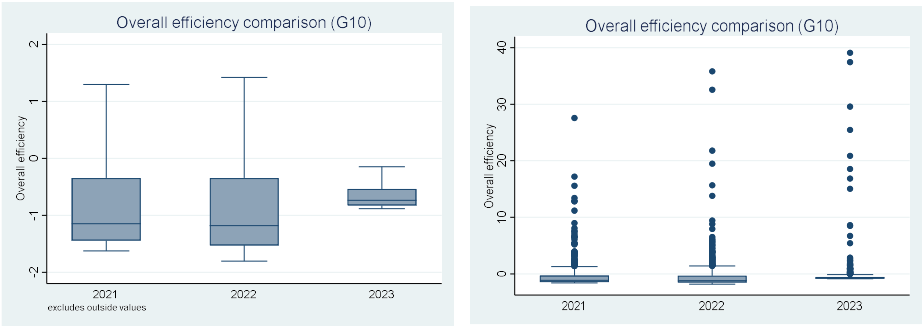

Fig. 2. Dynamics of overall efficiency for food production without outliers (left) and with outliers (right).

The events of 2022 have affected the widening gap in the quality of financial management between the main inefficient mass of industry representatives and a significantly fewer leaders. In 2022, this process resulted in an increase in the spread of the overall efficiency indicator with its median value almost unchanged. In 2023, the quality of financial management of the bulk of companies has increased, but their gap with the "leaders" of the industry has increased.

Conclusion

The tool proposed by the authors of this study made it possible to analyze the quality of financial management for Russian manufacturing companies in industry and time sections. Previously, its capabilities were tested on representatives of the financial sector. It was possible to cover far from all representatives of this sector of the market due, first of all, to their chronic loss-making and specific features of accounting policy.

For the manufacturing companies included in the set, it can be concluded that there is a noticeable influence of industry specifics on this indicator, as well as a significant impact of sanctions on the quality of financial management, which is expressed in the formation of groups of industry "leaders" in the field of financial management.

Reference list

1. Поляков К.Л., Полякова М.В., Жукова Л.В. Структура оценки качества менеджмента российских банков. // Экономический журнал ВШЭ. 2022. 26(3). С 450–474.
2. Поляков К.Л., Полякова М.В. Влияние специализации банковского бизнеса на его эффективность. // Экономический журнал ВШЭ. 2023; 27(3): 390–411.
3. Aigner, D., Lovell, C. K., Schmidt, P. (1977) "Formulation and estimation of stochastic frontier production function models." Journal of Econometrics 6 (1): 21–37.
4. Banker, R.D. (1984) "Estimating the Most Productive Scale Size Using Data Envelopment Analysis." European Journal of Operational Research 17: 35–44.
5. Banker R.D., Chang H. The Super-efficiency Procedure for Outlier Identification, Not for Ranking Efficient Units // European Journal of Operational Research. 2006. 175(2). P. 1311–1320.
6. Berger, A.N., and Humphrey D.B. Efficiency of Financial Institutions: International Survey and Directions for Future Research. // European Journal of Operational Research 1997. 98. P. 175–212.
7. Charnes, A., Cooper, W. W., Rhodes, E. (1978) "Measuring the Efficiency of Decision Making Units."European Journal of Operational Research 2 (6): 429–444.
8. Charnes A., Cooper W. W., Lewin A. Y., Seiford L. M. (1994) "Data Envelopment Analysis: Theory, Methodology, and Application." NY: Springer Science+Business Media
9. Camanho, A.S., and Dyson, R.G. Cost efficiency, production and value-added models in the analysis of bank branch performance // Journal of the Operational Research Society. 2005. 56. P. 483–494.
10. Cooper W. W., Seiford L. M., Tone K. (2007) "Data envelopment analysis. A comprehensive text with models, applications, references

and dea-solver software.” 2nd ed. NY: Springer science+business media
11. Cooper W. W., Seiford L. M., Zho J. (2004) “Handbook on data envelopment analysis.” NY: Kluwer Academic Publishers
12. Kumbhakar S. C., Lovell C. A. K. (2003) “Stochastic Frontier Analysis.” NY: Cambridge University Press
13. Pindyck R. S., Rubinfeld D. L. (2018) “Microeconomics.” 9 ed. NY: Pearson Education
14. Siems T.F. (1992) “Quantifying Management's Role in Bank Survival.” Economic Review. First Quarter. Federal Reserve Bank of Dallas